

## NON-FERROUS BASE-METALS GROUP MINERALS

INDIA is far behind to some of the advanced countries in respect of the production and consumption of base metals which are the true indicators of the industrial activity of any country. In fact no mineable reserves of some base metals like tin etc. are present. The chief base metal minerals in India where some mining and metallurgical activity is seen and being developed are confined to copper, lead, zinc and aluminium. The production of copper in India hardly meets internal demand. The same is the case with lead and zinc metals. It is only in recent years that concerted efforts are continued for exploration and exploitation of new copper, lead and zinc deposits in the country and setting up new copper and zinc smelters for smelting of the indigenous as well as imported concentrates. But in the case of aluminium industry, it can be considered self-sufficient in respect of the bauxite reserves for meeting the requirements of expanding indigenous industry as well as for export market.

### (1) COPPER ORE

#### Regional Occurrences and Reserves

Copper minerals occur very widely throughout the country but the important workable deposits are confined to a few well-known mineralised ones in Peninsular India, where they occur both in the earliest crystalline formations as well as in several younger rock systems, namely Cuddapahs, Bijawar, Arvallis etc. while those of extra-peninsular India are found in highly metamorphosed formations. The ores are generally very finely disseminated in cracks and fissures and foliations with lesser local concentration in the parent rocks. The chief copper deposits are found in Andhra Pradesh (Guntur, and Kurnool Districts) Bihar (Singhbhum District), Rajasthan (Alwar, Jhunjhnu, Jaipur, Jhalwar etc. districts), Gujarat (Banas-kantha District) and Madhya Pradesh (Balaghat District). The known reserves of copper ore are given in Table 1.19.

A total of about 300 million tonnes of which 35.0 million are measured, 59 million, indicated and 196 million are inferred and possible reserves.

A recent estimate of copper ore reserves is put at 342 million tonnes.

#### Uses

Copper metal has got a wide range of industrial and domestic applications, such as electrical, non-electrical, castings bearing material, kitchen utensils, coinage, handicrafts, chemicals, fungicide and insecticide manufacture.

#### Production, Domestic Consumption, Export and Import

Production of copper metal amounted to 7,674 tonnes in 1959 and 50,840 tonnes metal were imported. In 1971, production was 9,554 tonnes with imports going upto 59,043 tonnes to meet internal demand. According to planning commission, the domestic requirement of copper metal is expected to increase to 2,18,000 tonnes by 1980-81. Although the indigenous metal production is expected to be around 75,000 to 80,000 tonnes by that time with the starting of the new units at Khetri, Rakha etc. a wide gap of about 143,000 tonnes will be still left over between the demand and output, which may have to be filled in by imports. The copper mineral and metal production and consumption in India is given in Table 1.20.

Some minor export of copper, brass and bronze was done during 1963-67 as seen in table No. 1.20. The production of copper ore in 1972 and 73 is 8,72,923 tonnes and 10,93,000 tonnes and copper metal in 1972 and 73 are 10,500 and 11,740 tonnes respectively. The quantity of imports of copper metal and alloys during 1969-71 comes to 1,58,000 tonnes and in 1972 53,621 tonnes and in 1973

TABLE NO. 1.19—COPPER ORES RESERVES (GSI: IBM ETC.) AS ON 1-1-1975 (IN MILLION TONNES)

Locality	Proved		Probable		Possible	
	tonnage	% Cu	tonnage	% Cu	tonnage	% Cu
Locality	(2)	(3)	(4)	(5)	(6)	(7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>(1) Andhra Pradesh</b>						
<b>Agnigundala Belt</b>						
(i) Bandalamottu	—	—	0.775	1.71		
			0.261	0.56	—	—
(ii) Nallakonda	—	—	3.144	1.82	—	—
(iii) Dhukonda	—	—	2.154	1.51	—	—
<b>(2) Bihar</b>						
(i) Mosaboni	3.77	2.1	3.40	2.04	—	—
(ii) Surda	—	—	—	—	13.485	1.91
(iii) Pathargora	0.24	1.77	—	—	—	—
(iv) Kendadih	0.05	2.7	—	—	—	—
(v) Rakha (Mine Block & Roam Sidheswar)	30.4	1.57	18.0	1.54	15.5	1.50
(vi) Tamapahar	—	—	9.82	1.41	6.30	1.38
(vii) Ramachandra Pahar (Turamdih Deposit)	—	—	12.59	1.62	—	—
<b>(3) Karnataka</b>						
(i) Ingladahalli	0.17	2.26	—	—	0.83	1.42
(ii) Ingladahalli Kunchiganahalli	—	—	0.22	1.46	—	—
(iii) Kalyadi	—	—	—	—	1.04	1.32
(iv) Kalaspura	—	—	—	—	2.00	0.5 to 0.8
(v) Tinthiwi	—	—	—	—	2.80	0.74
					0.65	0.84
<b>(4) Madhya Pradesh</b>						
(i) Malanj Khaud	—	—	40.83	1.43	17.11	1.17
<b>(5) Rajasthan</b>						
(i) Madhan Kudhan	46.2	1.0	46.6	1.0	—	—
(ii) Kolihan	—	—	12.31 &	2.40 &	1.50	1.00
			11.81	0.60	—	—
(iii) Chandmari	—	—	2.36	1.04	—	—
			3.53	0.88	—	—
(iv) Akwali	—	—	1.04	1.60	0.61	1.33
(v) Intervening Block (Kolihan)	—	—	—	—	0.35	0.5-0.8
(vi) Kolihan North Block	—	—	1.03	0.5-1.15	0.26	0.50-1.15
(vii) Dhoitmala	—	—	—	—	0.25	0.32-2.21
(viii) Satkeri	—	—	—	—	3.28	0.99
					0.60	1.78
(ix) Kho-Dariba	—	—	0.56	2.46	—	—
(x) Bhagoni	—	—	2.66	1.07	2.56	1.07
			0.85	0.45	—	—
(xi) Pur-Dariba	—	—	1.17	1.03	0.47	1.03
(xii) Derpara-Bonera	—	—	0.99	1.36	0.51	1.25
(xiii) Deri	—	—	—	—	0.80	1.14
<b>(6) Tamil Nadu</b>						
(i) Mamandur	—	—	0.92	0.63	—	—
<b>(7) Gujarat</b>						
(i) Ambamata (Partly copper ore)	—	—	6.20	1.38	—	—
<b>(8) Maharashtra</b>						
(i) Pular-Pasori	—	—	—	—	0.122	1.21-1.86
<b>(9) Orissa</b>						
(i) Kesarpar	—	—	0.80	1.00	1.60	1.00
<b>(10) Meghalaya</b>						
(i) U.K.I.J. Hills	—	—	—	—	0.12	0.35

**TABLE 1.20—PRODUCTION OF COPPER MINERAL AND METAL AND IMPORTS AND EXPORTS (IN TONNES)**

Year	Mineral Production	Metal Production	Metal Imports	Copper Export	Brass & bronze export
1963	4,74,354	9,582	74,008	336	421
1964	4,72,963	9,475	67,471	776	1,149
1965	4,67,580	9,360	60,127	379	1,159
1966	4,84,842	9,428	25,816	117	665
1967	4,69,578	8,904	44,783	64	600
1968	4,83,646	9,300	35,259	1,243	1,144
1969	5,10,456	9,751	48,402	2,006	1,086
1970	5,18,302	9,300	50,970	3,835	1,214
1971	6,66,379	9,500	59,043	3,434	1,446
1974	14,28,640				
1975	18,30,759				

55,173 tonnes respectively and concentrates in 1969-71 1,25,000 tonnes. The export of copper metal and alloys during 1972 and 1973 comes to 4,743 tonnes and 4,279 tonnes respectively. The estimated consumption and requirement and production of copper metal in 1979 and 1984 are as follows (Planning Group).

Copper Metal (in tonnes)	1979	1984
(1) Consumption and requirement estimated	105,000	221,000
(2) Production estimated	60,000-80,000	100,000-120,000

It is evident that the gap between the consumption requirement and the estimated indigenous production will be large. This gap is expected to be bridged to some extent when some of new prospects are developed and put into operation in the coming years. The chances of augmenting the resources are bright because of the various field activities Geological Survey of India supported by the aero-magnetic anomalies of the airborne mineral survey (operation hard-rock)

## (2) LEAD-ZINC ORES

### Regional Occurrences, Reserves and Uses

The lead and zinc ore deposits are fewer when compared to copper ore. They are reported to occur in most of the states except Kerala. Among them Zawar deposits of Rajasthan are presently being worked. Some of the important deposits which are proved/in the process of proving are (i) Bandalamottu and Dhukonda of Andhra Pradesh, (ii) Sargipalli of Orissa, (iii) Ambamata of Gujarat and (iv) Mochia Magra, Balaria, Zawar Mala, Baroi and Dariba-Rajpura of Rajasthan. The total reserves of all categories (Proved, probable and possible) come to about 130 to 145 million tonnes the details of which are given in Table 1.21. Lead is widely used industrially due its unusual combination of physical and chemical properties. It is used for cable-sheathing, storage battery grids, alloys (type metal, bronze, die-casting etc.), atomic reactors as shield, water pipes, and chemical industry. Zinc metal is used in alloying, in dry battery cells, as electrodes, chemical, metallurgical and pigment, rubber and textile industries.

A recent estimate of lead ore reserves (October 1976) is put at 120 million tonnes and Zinc ore at 101 million tonnes.

TABLE 1.21—RESERVES OF LEAD-ZINC ORE (IN MILLION TONNES) AS ON 1.1.1975

Area	Proved			Probable			Possible		
	M. Tonnes	Pb%	Zn%	M. Tonnes	Pb%	Zn%	M. Tonnes	Pb%	Zn%
<b>(1) Andhra Pradesh</b>									
(i) Bandalamottu	—	—	—	11.46	6.1	—	—	—	—
(ii) Dhukonda	—	—	—	0.46	8.98	—	—	—	—
(iii) Karempudi	—	—	—	—	—	—	0.65	1.38	0.96
(iv) Vummidivaram	—	—	—	0.30	2.69	—	—	—	—
(v) Zangamarajupalle	—	—	—	—	—	—	{ (1.53 1.54)	{ 2.92 0.36	{ 4.21 1.08
<b>(2) Gujarat</b>									
(i) Ambamata	—	—	—	6.22	5.53	5.90	—	—	—
(ii) Khandia	—	—	—	—	—	—	2.30	4.50	—
								(Pb+Zn)	
<b>(3) Orissa</b>									
(i) Sargipalli	—	—	—	{ (4.47 2.03)	{ 5.68 6.40	—	{ 1.23 4.77	{ 5.68 5.20	—
<b>(4) Rajasthan</b>									
(i) Hameta Mogra	—	—	—	—	—	—	18.30	—	5.00
(ii) Mochia Mogra	8.30	7.00	—	—	—	—	10.16	7.00	—
		(Zn+Pb)						(Zn+Pb)	
(iii) Mochia East	—	—	—	—	—	—	7.10	{ 0.35 1.67)	{ 5.73 6.59
(iv) Mochia Central	—	—	—	—	—	—	7.52	1.76	3.85
(v) Mochia West	—	—	—	—	—	—	20.00	?	?
(vi) Balaria	—	—	—	—	—	—	17.17	0.92	6.06
(vii) Zawarmala	—	—	—	—	—	—	11.30	2.15	3.90
(viii) Baroi Magra	—	—	—	1.65	2.71	2.74	2.91	2.71	2.74
				(Additional Geological Reserves)					
(ix) Rajpura-Dariba	12.68	1.20	5.50	12.34	1.20	5.50	27.26	1.20	5.50
				(Additional reserve of Gossan: et M. ton)					
(x) Dedwas (South)	—	—	—	2.94	1.41	2.82	1.81	1.47	2.72
(Additional reserve: 3 M. Tonnes of 4.2% Zn-Pb)					(+Ag 44 mg)			(+Ag 43 mg)	
(xi) Delwas (North)	—	—	—	—	—	—	0.60	1.36	2.51
(xii) Derpura	—	—	—	2.03	0.82	3.77	0.69	0.94	3.72
(Additional reserves: 1.5 M. Ton of 4.5% Zn-Pb)									
(xiii) Deri	—	—	—	0.58	6.82	9.06	0.24	6.82	9.06
<b>(5) Bihar</b>									
(i) Sahabad	—	—	—	—	—	—	11.00	0.44%	—
								(Pb+Zn)	
<b>(6) Meghalaya</b>									
(i) U.K. & J. Hills (Wmpyotha)	—	—	—	—	—	—	0.12	0.40	2.83
<b>(7) Tamil Nadu</b>									
(i) Mamandur	—	—	—	0.92	2.00	2.73	—	—	—
<b>(8) Uttar Pradesh</b>									
(i) Askot	—	—	—	—	—	—	0.77	2.64	3.95

## Production, Domestic Consumption, Import and Export

The production of lead concentrate and zinc concentrate (Mostly from Rajasthan), production of lead metal, exports of lead and zinc metals, imports of lead and zinc metal and concentrates are given in Tables 1.22 & 1.23.

## Future Outlook

As seen from the tables 1.21, 1.22 & 1.23 and from the known lead-zinc ore reserves of the country it may be stated that they may be adequate for the coming 3 to 4 decades to sustain an annual production of 55,000 tonnes of lead and 71,000 tonnes of zinc. By 1980-81 the demands to lead and zinc metals are expected to rise to 1,80,000 tonnes and 2,80,000 tonnes respectively, which are to be supplemented by imports as the anticipated indigenous production capacity will not be sufficient enough to meet the consumption requirements. Meanwhile new resources of these metals are to be proved and developed to bridge the gap between supply and demand as far as practicable. The estimated production, consumption and requirement of lead and zinc metals for the years 1979-84 are given in Table 1.24.

### (3) ALUMINIUM ORE (BAUXITE)

India can be considered self-sufficient in respect of bauxite, the ore of aluminium for many years to come in the light of the overall resources position of the country and the present exploration and exploitation programmes to meet the growing indigenous requirements in the aluminium industry, refractory and chemical industries, as well as for the export market. In recent years an increase in the use of aluminium metal for conventional purposes as well as for the substitution programme of non-ferrous base metals particularly copper in the manufacture of light alloys has necessitated to expand the bauxite mining activity in the country.

### Reserves, Specifications and Uses

The total reserves of bauxite according to G.S.I. estimates have been put at 231.95 million tonnes\*. The deposits are mostly associated with laterite and occur as cappings of high altitude plateaux

Recent estimates is 2300 millions tonnes including East Coast deposits.

in Plamau and Ranchi districts of Bihar; Poonch, Riiasi and Udampur districts of Jammu & Kashmir, Saurashtra, Kutch and Surat districts of Gujarat, Jabalpur, Balaghat, Mandla, Bilaspur, Shahdol, Durg, Raipur, Surguja etc. districts of M.P., Salem, Madura, and Nilagiris districts of Tamil Nadu, Kolhapur, Ratnagiri and Kolaba districts of Maharashtra, Belgaum and North and South Kanara districts of Karnataka, Kalahandi and Sambalpur districts of Orissa, and Allahabad and Banda districts of U.P. Some recent occurrences has been reported from Visakhapatnam district of A.P. which may run to a few million tonnes. The state-wise reserves of bauxite in India are given in Table 1.25.

### Specifications and Uses

Various specifications are to be adhered to of the bauxite ore depending on the industry to which it is put to. Thus for aluminium industry which consumes the maximum ore, bauxite should have  $Al_2O_3\%$  = 50% and above, 1.8-2% (Max)  $SiO_2$  (some tolerate upto 5%)  $Fe_2O_3\%$  = 6-11% and  $TiO_2\%$  = 8-11%. But some relaxation is shown in recent years by the smelters of these above specifications.

Chemical and petroleum industry require bauxite containing  $Al_2O_3\%$  58% and above,  $SiO_2\%$  = upto 3.0% (more than 2% is usually not acceptable),  $Fe_2O_3\%$  = 1.5-4.0%, and  $TiO_2\%$  = 4.0% (Max.).

ISI specification (IS: 3605-1966) for bauxite to be used for chemical and petroleum industry states that bauxite shall consist predominantly of gibbsite, and shall be dirty white, light-grey, cream or pink in colour with the following analysis:  $LOI\%$  = 32.0% Max.  $SiO_2\%$  = 3.0% (Max),  $Al_2O_3\%$  = 58.0% (Min),  $Fe_2O_3\%$  = 2.0% (Max),  $TiO_2\%$  = 4.0% (Max),  $P_2O_5\%$  = 0.3 (Max),  $MnO\%$  = 0.1% (Max) and  $CaO\%$  = 2.0% (Max).

Bauxite used for refractory manufacture is to contain  $Al_2O_3\%$  = 55% and above (40-50% also are being used),  $SiO_2\%$  = 2-6%  $Fe_2O_3\%$  = 4%,  $TiO_2\%$  = 10% Max.

Abrasive industry requires bauxite with  $Al_2O_3\%$  = 50% and above,  $SiO_2\%$  = 5% (Max) and  $Fe_2O_3\%$  = 15% (Max.).

Bauxite has in recent times, been used by steel industry as a slag corrective (to fluidize the slag)

**TABLE 1.22—PRODUCTION OF LEAD AND ZINC CONCENTRATES AND LEAD AND ZINC METALS (IN TONNES)**

Product	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
(1) Lead Conc.	5,151	3,995	3,566	3,300	3,880	4,262	5,005	7,671	10,069	13,830
(2) Zinc Conc.	8,900	10,029	12,930	13,781	15,000	15,865	17,005	23,913	29,060	38,339
(3) Lead Metal	2,479	2,473	1,600	1,900	1,900	1,500	2,700	2,636	3,986	4,769
(4) Zinc Metal	N.A.	3,000	20,500	23,400	23,400	21,200	25,200	12,506	21,105	25,727

Source: I.B.M.

**TABLE 1.23—EXPORT AND IMPORT OF LEAD AND ZINC METALS AND CONCENTRATES (IN TONNES)**

Product	1966	1967	1968	1969	1970	1971	1972	1973	1974	
<b>Exports</b>										
(1) Lead Metal		5	28	3	11	32	44	32	137	37
		(mostly scrap)								
(2) Zinc Metal	2,532	2,502	650	731	2,348	3,244	1,437	371	—	
<b>Export</b>										
(1) Lead Conc.		30	27	7	81	119	112	9	28	
(2) Lead Metal	38,093	41,147	35,221	30,125	37,820	37,344	38,275	38,889		
(3) Zinc Metal	37,925	74,356	106,663	30,866	71,110	92,287	79,000	65,774		
(4) Zinc Ore and Conc.		N.A.	N.A.	N.A.	29,996	48,901	45,862	37,756	34,751	

(Source: I.B.M. etc.)

**TABLE 1.24—ESTIMATED PRODUCTION, CONSUMPTION AND REQUIREMENT OF LEAD AND ZINC METALS (IN '000 TONS.)**

Product	Production		Consumption	
	1979	1984	1979	1984
(1) Lead Metal	25-30	50-60	120	140
(2) Zinc Metal	80	100	180	200

**TABLE 1.25—STATE-WISE RESERVES OF BAUXITE IN INDIA (IN MILLION TONNES)**

State	Measured	Indicated	Inferred
(1) Bihar	13.04	11.20	21.43
(2) Goa	2.75	4.72	—
(3) Gujarat	21.65	—	22.40
(4) Jammu & Kashmir	—	—	2.61
(5) Karnataka	1.14	14.53	1.99
(6) Kerala	—	8.43	5.36
(7) Madhya Pradesh	59.08	12.83	28.58
(8) Maharastra	46.57	10.60	20.15
(9) Orissa	2.53	12.00	5.90
(10) Tamil Nadu	8.58	—	—
(11) Uttar Pradesh	2.22	1.40	—

(Source: G.S.I.)

N.B.: Additional Reserves are under estimation for East Coast Bauxite.

as a substitute for fluorspar to a large extent. The specifications of bauxite desired by the various steel plants are given in Table 1.26.

Besides in the above industries bauxite is also used in the manufacture of emery powder, cement, paint, and in the refining of Kerosene, lubricating oils, sugar etc. In recent times the usage of aluminium metal has been very much increased as a good substitute metal for copper in electrical industry and for zinc in aluminizing instead of galvanizing and as a coinage alloy with magnesium metal.

### Production, Domestic Consumption and Export

The production of bauxite since 1965 state-wise is given in Table 1.27. The consumption of bauxite in different industries is given in Table 1.28. The production of aluminium metal in India and imports during the past few years are given in Table 1.29.

A sizable amount of bauxite ore and some aluminium metal have been exported during the last few years and given in Table 1.30.

### Demand Projections and Future Outlook

The aluminium industry has phased expansion programme to meet the growing needs of national

and international markets. The Planning Commission has put production targets of 215,000 tons, 500,000 tons and one million tons of aluminium metal for 1973-74, 1980-81 and 1988-89 respectively, even though a decline is faced from 1972 to 1973 in the production. The anticipated production targets of the future can be achieved by increasing the exploration and exploitation activities of the existing and new deposits to feed the smelters to reach their full capacity of production. Detailed grade wise assessment of the well known deposits of Bihar etc. and the new finds of Andhra Pradesh, Gujarat etc. must be carried out. The off-grade ores must be put into use by upgrading them by suitable beneficiation methods.

**TABLE 1.28—DOMESTIC CONSUMPTION OF BAUXITE (IN TONNES)**

Industry	1967	1968
(1) Aluminium	526,045	704,256
(2) Refractory	39,525	53,316
(3) Chemical	34,396	39,713
(4) Cement	25,449	32,114
(5) Iron & Steel (flux)	12,840	17,916
(6) Others	8,996	11,728
<b>Total</b>	<b>647,251</b>	<b>859,043</b>

(Source : I.B.M.)

**TABLE 1.26—BAUXITE SPECIFICATION FOR STEEL INDUSTRY**

Assay %	Durgapur	Bhilai	Rourkela	VISL	TISCO
Al <sub>2</sub> O <sub>3</sub>	57-61	50.0 (Min)	50.54	60.5	54.98
Fe <sub>2</sub> O <sub>3</sub>	7-10	—	16.20	1.7	6.18
TiO <sub>2</sub>	12.5+4	8 (Max.)	(TiO <sub>2</sub> =less than 9.0%) 2-5	5.2	10.2
SiO <sub>2</sub>	—	—	—	—	—
Combined Size	20 24-100 mm	— 25-80 mm	—	—	— 50-100 mm

**TABLE 1.27—PRODUCTION OF BAUXITE (STATE-WISE) IN TONNES**

State	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1. Bihar	322,329	379,769	403,798	463,612	543,711	493,155	552,096	594,953			
2. Goa	—	—	—	14,806	58,460	74,581	46,552	3,524			
3. Gujarat	180,351	171,850	130,783	151,334	250,401	244,508	217,529	276,118			
4. Karnataka	18,900	19,076	21,055	16,848	38,419	85,286	54,405	67,799			
5. Madhya Pradesh	109,306	107,523	174,330	183,753	177,137	236,050	232,719	294,079			
6. Maharashtra	1,277	8,985	23,487	45,926	12,420	121,354	300,759	315,521			
7. Tamil Nadu	68,416	59,606	47,876	77,942	72,183	84,783	73,558	101,161			
8. Uttar Pradesh	6,070	3,199	2,824	3,189	22,158	19,924	9,148	5,801			
<b>Total :</b>	<b>706,649</b>	<b>749,948</b>	<b>804,093</b>	<b>957,410</b>	<b>1084,899</b>	<b>1359,641</b>	<b>1486,766</b>	<b>1658,956</b>	<b>1267,064</b>	<b>1114,416</b>	<b>1269,669</b>

(Source : I.B.M.)

**TABLE 1.29—INDIGENEOUS PRODUCTION AND IMPORT OF ALUMINIUM METAL (IN TONNES)**

Aluminium Metal	1967	1968	1969	1970	1971	1972	1973	1974	1975
(1) Indigenous production	95,546	120,138	123,554	161,083	178,179	179,103	154,336	128,917	156,103
(2) Imports	48,401	13,102	2,091	3,938	23,554	3,441	1,281	1,278	

(Source : I.B.M.)

**TABLE 1.30—EXPORT OF BAUXITE AND ALUMINIUM METAL (IN TONNES)**

Export	1967	1968	1969	1970	1971	1972	1973	1974
(1) Bauxite Ore	60,873	96,916	67,726	118,885	53,782	27,575	28,494	18,264
(2) Aluminium metal	1,790	17,731	21,226	12,304	7,886	9,624	6,442	5,626

(Source : I.B.M.)