

BORON MINERALS



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**BORON MINERALS**

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**GOVERNMENT OF INDIA  
MINISTRY OF MINES  
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## 6 Boron Minerals

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**B**oron minerals occur mostly as borates which are deposited from volcanic gases or hot springs near volcanic activities. The deposits, predominantly of borax and sassolite are formed as a result of drying up of shallow saline and alkaline tertiary lakes called 'Playa'. The principal boron minerals are borax, hydrated sodium borate ( $\text{Na}_2\text{O} \cdot 2\text{B}_2\text{O}_3 \cdot 10\text{H}_2\text{O}$ ), kernite (rasorite), hydrated sodium borate ( $\text{Na}_2\text{O} \cdot 2\text{B}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$ ), colemanite, hydrated calcium borate ( $\text{Ca}_2\text{B}_6\text{O}_{11} \cdot 5\text{H}_2\text{O}$ ), and ulexite, hydrated sodium calcium borate ( $\text{NaCaB}_5\text{O}_9 \cdot 8\text{H}_2\text{O}$ ). Besides the above four boron minerals of commercial importance, two minerals; viz, sassolite ( $\text{H}_3\text{BO}_3$ ), the natural boric acid and boracite ( $\text{Mg}_3\text{B}_7\text{O}_{13}\text{Cl}$ ) are less important.

Borax is not produced in India presently. However, it was obtained since early times from the Salt Lakes in Jammu & Kashmir in India and Tibet. The domestic requirements of boron minerals are met solely through imports of crude borate which is refined in the country for producing borax and boric acid.

### RESOURCES

Economically workable deposits of borax have not been established in the country so far. The only deposit of little economic significance is reported from Puga Valley in Leh district, Jammu & Kashmir. As per the UNFC system, total resources of borax as on 1.4.2010, are estimated at 74,204 tonnes in Jammu & Kashmir. All resources are of reconnaissance category, viz, UNFC Code 334. Occurrences are also reported from Surendranagar district, Gujarat and Nagaur district, Rajasthan. The bittern obtained from Sambar Lake in Jaipur district, Rajasthan, also contains about 0.5% borax.

### USES

Glass and porcelain industries are the major consumers of borax and boric acid. It is an essential component of heat-resisting borosilicate glass, glass fibres and industrial & optical

glass. In glass, enamels and ceramics, it controls thermal expansion, improves durability, assists melting processes and adds to inorganic colours and decorations.

Borax is used in medicine (boric powder), leather processing, adhesive, corrosion inhibition, ferrous wire manufacture, flame-proofing and timber preservation.

Borax is used as a flux in brazing, welding, soldering and in the manufacture of artificial gems like, cubic boron nitride, (commercially called 'Borazon') which equals diamond in hardness and boron carbide, titanium boride and tungsten boride which are next to diamond in hardness.

Its easy solubility and property to soften hard water find applications in soaps, cleaners & detergents and for water treatment. Because of its mild alkalinity and germicidal nature, it is used in manufacturing toothpastes and mouth washes. In cosmetics, borax is used as an antiseptic and emulsifying agent. As a decolourising agent, it is used in vanaspati industry. In textile industry, borax is used as a decolourising agent as well as for maintaining the alkalinity of solutions used for producing rayons. It prevents mould formation in citrus fruits. In agriculture, borax is used as an essential plant nutrient.

Boron compounds are used for fertilizers, algicides, herbicides and insecticides. Borax and boric acid are used in fire-retardant treatment and as food grain preservative, respectively.

Borate ester is used as dehydrating agent, special solvent and catalyst in chemical industry. In nuclear reactor, boron acts as neutron absorber. "Boron neutron capture therapy", a form of radiochemotherapy, is becoming increasingly important for treatment of certain forms of cancers and boron neutron capture synovectomy for treatment of arthritis.

## BORON MINERALS

Borates are consumed mainly in glass fibre for insulations and textile-grade fibre. Borates are also used as anti-knock agents in gasoline. Diborane (gas), pentaborane (liquid), and decaborane (solid) are potential jet and rocket engine fuels. Boron hydride also has potential value as rocket fuel. The high energy fuel value imparted by the addition of boron compounds has given considerable strategic significance to borates. Another use of borates is the invention of oxgano-sodium borate (liquibor) for use in hydraulic brake fluids.

### Substitutes

Substitutes in applications such as soaps, detergents, enamels and insulations are available. In detergents, boron compounds can be replaced with chlorine and enzymes. Lithium compounds can be used to make enamels and glass products. Insulation substitutes include cellulose, foams and mineral wools. Substitution of borosilicate glass by plastic materials may reduce the use of boron.

### Technical Possibilities

A proprietary process called 'Hydrogen on Demand' has been developed using water and sodium borohydride. Hydrogen from the system can be used in fuels cells or internal combustion engines. A longer-life battery based on boron has also been designed. Synthetic diamond containing about 3% boron which is normally a semiconductor becomes superconductor at 4<sup>0</sup>K. Boron-doped diamond thus has numerous possible applications as it can carry electricity without resistance.

Improvements made in evaporating brine solutions are widening the choice of source. Production of boric acid through solution mining of colemanite is a possibility.

### Environmental Concern

Natural borates are not very toxic to animals but can be toxic to plants even though low levels of boron are essential for plant life. Boron-hydrogen compounds known as boranes which do not occur in nature are highly toxic and have posed problems in some industrial applications. Environmental concerns have

hastened substitution in soaps and detergents. In Europe, borates continue to be listed under hazardous substances and the risk evaluated for their safety under conditions of normal handling and use related to classification and labelling already exists. The US Food and Nutrition Board announced that the essentiality data on boron was adequate to establish a daily tolerable Upper Intake Level (UL) at 20 mg boron.

## INDUSTRY

In borax manufacturing process, crude sodium borate is dissolved in water, charged, oxidised, crystallised and centrifuged. Centrifuged material is then dried to get borax decahydrate.

Crude calcium borate lumps are crushed and wet-ground with mother liquor to make slurry. This slurry is decomposed with sulphuric acid to give calcium sulphate and boric acid. Boric acid is separated by filtration, purified, cooled and centrifuged to produce boric acid granules which are powdered as per demand.

Borax Morarji Ltd, Ambernath, Thane district, Maharashtra, engaged in refining of imported crude borates to produce borax and boric acid has installed capacities of 17,000 tpy borax and 6,000 tpy boric acid. National Peroxide Limited at Vadavali, Thane district, Maharashtra, produces sodium perborate which is used as a bleaching agent. The installed capacity of that plant is 1,200 tonnes per year. Indo Borax and Chemical Limited operates borax and boric acid plants at Pithampur, Madhya Pradesh.

Ferro-boron is a boron ferro-alloy containing 0.2% to 24% boron used primarily to introduce small quantities of boron into speciality steels. Domestic production of ferro-boron was 83 tonnes and 90 tonnes, in 2009-10 and 2010-11, respectively.

## CONSUMPTION

The reported consumption of borax in the organised sector was at 23,700 tonnes in 2011-12. Chemical and glass industries were the major consumers accounting for about 95% borax consumption (Table-1).

BORON MINERALS

**Table – 1 : Reported Consumption of Borax,  
2009-10 to 2011-12  
(By Industries)**

(In tonnes)			
Industry	2009-10	2010-11(R)	2011-12(P)
<b>All Industries</b>	<b>23800</b>	<b>23700</b>	<b>23700</b>
Ceramic	800 (5)	800 (5)	800 (5)
Chemicals®	19900 (5)	19900 (5)	19900 (5)
Glass	2500 (22)	2200 (21)	2200 (21)
Graphite products	100 (7)	100 (7)	100 (7)
Others (abrasive, cosmetic, paint, paper, pharmaceutical, refractory, textile and vanaspati)	500 (14)	700 (15)	700 (15)

*Figures rounded off.*

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

*(\* Includes actual reported consumption and/or estimates made wherever required).*

*@ Includes consumption of ulexite and colemanite.*

## WORLD REVIEW

The estimated world reserves of boron minerals are about 210 million tonnes in terms of boric oxide. Countries with sizeable resources are Chile, China, Turkey, Russia, Peru and Argentina. The world reserves of boron minerals are given in Table-2.

Turkey, USA, Chile, Argentina, and Russia are the major producers of boron minerals. China also has substantial ore production. These countries contributed about 5 million tonnes to world production.

In Turkey, Government-owned Eti Maden operated processing plants at Bandirma and Kirka. A large tincal deposit at Kirka is the only commercial sodium borate deposit known in Turkey. Turkey was the world's largest producer of boron ore in 2011. Comibol of Bolivia is planning to develop the Salar de Uyuni salt flats for future borate production. A pilot plant is to be established for boric acid plant of 20,000 tpy capacity.

The world production of borates from 2009 to 2011 is given in Table-3.

**Table – 2 : World Reserves of Boron  
(By Principal Countries)**

(In '000 tonnes of boric oxide)	
Country	Reserves
<b>World: Total (rounded)</b>	<b>210000</b>
Argentina	2000
Bolivia	NA
Chile	35000
China	32000
Iran	1000
Peru	4000
Russia	40000
Turkey	60000
USA	40000

*Source: Mineral Commodity Summaries, 2013.*

**Table – 3 : World Production of Borates  
(By Principal Countries)**

(In '000 tonnes)			
Country	2009	2010	2011
Argentina	506	623	600 <sup>e</sup>
Chile	613	504	491
China <sup>(e)</sup>	290	300	300
Peru	187	293	-
Russia <sup>(e)</sup>	400	400	400
Turkey	1687	1910	2273
USA <sup>(e)</sup>	1200	1200	1250

*Source: World Mineral Production, 2007-2011.*

BORON MINERALS

**FOREIGN TRADE**

**Exports**

Exports of borax (total) increased to 1,765 tonnes in 2011-12 from 1,354 tonnes in the previous year. Exports in 2011-12 comprised natural borate 682 tonnes, sodium borate 570 tonnes and other borates 513 tonnes. Exports were mainly to Malaysia and Nepal. Exports of boric acid increased to 1751 tonnes in 2011-12 from 692 tonnes in the previous year. Exports were mainly to Nigeria (21%). In 2011-12, there was no exports of boron as compared to 48 tonnes in the previous year (Tables - 4 to 9).

**Imports**

Imports of borax (total) decreased to 96,994 tonnes in 2011-12 from 112,225 tonnes in the previous year. Imports in 2011-12 comprised natural borate 32,546 tonnes, sodium borate 59,706 tonnes and other borates 4,742 tonnes. Borax was mainly imported from Turkey (54%), USA (19%), China (6%), Argentina (5%) and Bolivia (3%). Imports of boric acid decreased to 7,918 tonnes in 2011-12 from 9,407 tonnes in the previous year. Boric acid was imported mainly from Turkey (50%) and USA (33%). In 2011-12, import of boron was negligible so also in 2010-11 (Tables 10 to 15).

**Table – 4 : Exports of Borax : Total  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>1354</b>	<b>53056</b>	<b>1765</b>	<b>85280</b>
USA	132	11929	217	15119
Sri Lanka	21	7057	73	13336
Malaysia	249	6913	325	10699
China	56	3417	125	10335
Bangladesh	23	2636	65	6591
France	-	-	30	4382
Myanmar	41	1219	79	2825
New Zealand	40	2209	36	2743
Saudi Arabia	132	3869	63	2676
Nepal	26	977	254	2225
Other countries	634	12830	498	14349

**Table – 5 : Exports of Natural Borate  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>528</b>	<b>6313</b>	<b>682</b>	<b>7194</b>
Kenya	329	1945	150	1766
Nepal	14	467	240	1645
Nigeria	56	1331	61	1223
Sri Lanka	2	40	56	593
Vietnam	1	91	4	332
Cameroon	38	403	15	292
Sudan	-	-	16	238
Ethiopia	++	18	10	232
USA	3	257	20	166
UAE	9	75	2	134
Other countries	76	1686	108	573

**Table – 6 : Exports of Sodium Borate  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>542</b>	<b>19558</b>	<b>570</b>	<b>30197</b>
USA	59	3828	174	12390
Malaysia	229	6443	325	10699
France	-	-	20	3039
Bangladesh	18	1250	22	1349
New Zealand	40	2209	18	1326
Saudi Arabia	105	2860	2	444
Nepal	5	270	4	186
Costa Rica	2	336	1	149
Singapore	-	-	1	111
Sudan	-	-	1	81
Other countries	84	2362	2	423

**Table – 7 : Exports of Borax : Other Borates  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>284</b>	<b>27185</b>	<b>513</b>	<b>47889</b>
Sri Lanka	16	6951	16	12682
China	56	3417	125	10335
Bangladesh	5	1387	43	5242
Myanmar	20	674	79	2825
USA	70	7844	23	2563
Pakistan	-	-	32	2163
Saudi Arabia	20	563	60	2148
Germany	-	-	10	1973
Chile	-	-	19	1429
New Zealand	-	-	18	1417
Other countries	97	6349	88	5112

BORON MINERALS

**Table – 8 : Exports of Boric Acid  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>692</b>	<b>36777</b>	<b>1751</b>	<b>83449</b>
Japan	5	487	338	24762
Nigeria	55	2661	377	13642
USA	341	17210	213	11339
Kenya	48	2828	194	4892
UK	5	194	40	4757
Australia	9	172	38	4197
Sudan	12	790	30	2280
Yemen Republic	15	1346	58	2220
Nepal	22	2272	54	2015
Cameroon	14	970	39	1530
Other countries	166	7847	370	11815

**Table – 9 : Exports of Boron  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>48</b>	<b>12818</b>	-	-
Chinese Taipei/ Taiwan	24	5962	-	-
China	15	5127	-	-
Thailand	3	969	-	-
USA	2	449	-	-
Bangladesh	2	244	-	-
Other countries	2	67	-	-

**Table – 10 : Imports of Borax : Total  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>112225</b>	<b>2427020</b>	<b>96994</b>	<b>2621167</b>
Turkey	48494	973587	52073	1208087
USA	27670	729620	18699	631095
China	1671	78206	5587	216378
Argentina	8694	196349	4448	111565
Spain	4261	115790	2913	85012
Bolivia	16645	191024	2965	35869
Germany	118	6268	628	32089
Russia	343	26260	206	29747
Chinese Taipei/ Taiwan	16	922	479	28239
Malaysia	552	20491	502	27371
Other countries	3761	88503	8494	215715

**Table – 11 : Imports of Natural Borate  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>48401</b>	<b>801445</b>	<b>32546</b>	<b>658862</b>
Turkey	18003	332144	16998	337978
Argentina	8548	191618	4448	111565
Spain	2178	48344	1806	48311
Bolivia	16645	191024	2965	35869
China	372	6298	1267	34249
Chile	1620	16547	1793	24096
Germany	3	45	401	11315
Italy	373	5814	518	10292
France	-	-	456	9357
Japan	-	-	473	7207
Other countries	659	9611	1421	28623

**Table – 12 : Imports of Sodium Borate  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>57107</b>	<b>1347556</b>	<b>59706</b>	<b>1642191</b>
Turkey	26637	563212	33151	825811
USA	26951	671363	18342	556110
China	164	3807	3098	96396
Spain	2051	65733	1107	36696
Malaysia	264	9146	372	18808
Korea Rep. of	100	2418	575	18208
Chinese Taipei/ Taiwan	-	-	455	12261
Japan	++	345	452	10985
UAE	24	690	379	10524
Italy	142	7636	250	10108
Other countries	774	23206	1525	46284

**Table – 13 : Imports of Borax : Other Borates  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>6717</b>	<b>278018</b>	<b>4742</b>	<b>320114</b>
China	1135	68100	1222	85733
USA	432	54164	357	74973
Turkey	3854	78230	1924	44298
Russia	304	25339	9	24648
Austria	372	18002	433	22784
Chinese Taipei/ Taiwan	16	922	24	15978
Germany	112	6052	58	15190
Malaysia	168	8704	130	8563
Israel	-	-	240	5139
Switzerland	-	-	84	4694
Other countries	324	18505	261	18114

BORON MINERALS

**Table – 14 : Imports of Boric Acid  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
<b>All Countries</b>	<b>9407</b>	<b>314416</b>	<b>7918</b>	<b>349536</b>
Turkey	5130	169595	3929	166883
USA	3179	108630	2662	121454
Poland	-	-	252	12360
China	103	3487	234	12202
Chinese Taipei/Taiwan	-	-	118	6112
UK	-	-	119	5570
Peru	431	13846	156	5560
Sri Lanka	-	-	59	3052
Korea Rep. of	-	-	80	2887
Unspecified	-	-	135	6167
Other countries	564	18858	174	7289

**Table – 15 : Imports of Boron  
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
<b>All Countries</b>	<b>++</b>	<b>1027</b>	<b>++</b>	<b>335</b>
USA	-	-	++	175
UK	++	349	++	119
Germany	++	29	++	24
Japan	++	9	++	17
Other countries	++	640	-	-

## FUTURE OUTLOOK

Increased usage of ceramic tiles will keep consumption of boron minerals in end user like the enamels, frits and glazes. Demand as a fertilizer will remain high, whereas, usage in soaps and detergents will be low because of

environmental concerns. Some cars have been replacing metal parts with reinforced fibreglass plastic parts of reduced weight to increase the efficiency of gasoline consumption. This may enhance the demand of borax for the production of fibre glass.