

# 19 Boron Minerals

---

**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 1.4.2005, 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. These industries consume over 50% production. 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 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.

As a fluxing agent, it is used in brazing, welding and soldering.

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 military significance to borates. Another use of borates is the invention of oxo-sodium borate (liquibor) for use in hydraulic brake fluids.

### Substitutes

Substitutions for boron minerals in several applications except glass products are in vogue. 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

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

A proprietary process called 'Hydrogen on Demand' has been developed using water and sodium borohydride. Hydrogen from the system can be used in fuel 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°K. Boron-doped diamond thus has numerous possible applications as it can carry electricity without resistance.

### 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.

Ferro-boron is a boron ferro-alloy containing 0.2% to 24% boron used primarily to introduce small quantities of boron in to speciality steels. Domestic production of ferro-boron was 80 tonnes each in 2006-07 and 2008.

## CONSUMPTION

The reported consumption of borax in the organised sector remained static at 23,900 tonnes in 2006-07 and 2007-08. Chemical and glass industries were the major consumers accounting for about 95% borax consumption (Table-1).

## BORON MINERALS

**Table - 1 : Reported Consumption of Borax,  
2005-06 to 2007-08  
(By Industries)**

Industry	(In tonnes)		
	2005-06(R)	2006-07	2007-08(p)
<b>All Industries</b>	<b>23800</b>	<b>23900</b>	<b>23900</b>
Ceramic	800 (6)	800 (6)	800 (6)
Chemical*	19900 (5)	19900 (5)	19900 (5)
Glass	2500 (25)	2500 (25)	2500 (25)
Graphite products	100 (23)	200 (23)	200 (23)
Others (abrasive, paint, paper, pharmaceuticals, refractory, textile and vanaspati)	500 (16)	500 (16)	500 (16)

*Figures rounded off.*

*Data collected on non-statutory basis.*

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

*\* Includes consumption of ulexite and colemanite.*

## WORLD REVIEW

The estimated world resources of boron minerals are about 410 million tonnes in terms of boric oxide. Countries with sizeable resources are Argentina, Turkey, Russia, USA, China and Peru. The world resources of boron minerals are given in Table-2.

Turkey, USA, Argentina, Chile and Russia are the major producers of boron minerals. China also has substantial ore production. These countries contributed about 5.1 million tonnes to world production. The production from USA is all from Searles Lake California, by US Borax Inc, and IMC Chemicals, a subsidiary of IMC Global Inc. In Turkey, government-owned Eti Bor (a subsidiary of Eti Holding, Inc., formerly known as Eti Bank, 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 2006. Borax Argentina SA (a subsidiary of Rio Tinto plc) is Argentina's leading producer and exporter to USA. Borax Argentina mined at three deposits, Tincalayu mine being the largest open-pit operation which despatches

about 100,000 tpy ore. In Chile, Quimica del Borax (Quiborax), Rio Grande, produces about 25,000 tpy ulexite at the Capina Mine. Quiborax also has a 35,000 tpy boric acid plants at EI Aguila. The company also operates 350,000 tpy capacity Surire ulexite deposit in northern Chile. In China, deposits of magnesium borates in Hunan, Jilin and Liaoning provinces are operated at about 870,000 tpy capacity. Refined derivatives-primarily borax decahydrate- capacity is about 350,000 tpy.

The world production of borates from 2005 to 2007 is given in Table-3.

**Table - 2 : World Resources of Boron  
(By Principal Countries)**

(In '000 tonnes of boric oxide)

Country	Reserve base
<b>World : Total (rounded)</b>	<b>410000</b>
Argentina	9000
Bolivia	NA
Chile	NA
China	47000
Iran	1000
Peru	22000
Russia	100000
Turkey	150000
USA	80000

*Source : Mineral Commodity Summaries, 2008.*

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

(In '000 tonnes)

Country	2005	2006	2007
Argentina	633	534	670
Chile	461	459	528
China	280 <sup>e</sup>	290 <sup>e</sup>	300 <sup>e</sup>
Russia	400 <sup>e</sup>	400 <sup>e</sup>	400 <sup>e</sup>
Turkey	2087	2373	2400 <sup>e</sup>
USA	1150	1150 <sup>e</sup>	1150 <sup>e</sup>

*Source : World Mineral Production, 2003-2007.*

BORON MINERALS

**FOREIGN TRADE**

**Exports**

Exports of borax (total) increased to 1,745 tonnes in 2007-08 from 900 tonnes in the previous year. Exports in 2007-08 comprised natural borate 1,144 tonnes, sodium borate 237 tonnes and other borates 364 tonnes. Exports were mainly to Bangladesh (24%), China (12%), Switzerland (6%), USA and Saudi Arabia (5% each). Exports of boric acid increased to 878 tonnes in 2007-08 from 788 tonnes in the previous year. Exports were mainly to Japan (46%), USA (23%) and Hong Kong (7%). In 2007-08, exports of boron increased to 341 tonnes from 89 tonnes in the previous year. Exports were mainly to Taiwan (90%) (Tables - 4 to 9).

**Imports**

Imports of borax (total) increased to 78,625 tonnes in 2007-08 from 63,067 tonnes in the previous year. Imports in 2007-08 comprised natural borate 37%, sodium borate (60%) and other borates (3%). Borax was mainly imported from Turkey (38%), USA (28%), Chile and Bolivia (10% each) and Argentina (7%). Imports of boric acid decreased to 6,645 tonnes from 9,085 tonnes in the previous year. Boric acid was imported mainly from Turkey (57%) and USA (28%). In 2007-08, imports of boron were 5 tonnes as against 31 tonnes in the previous year (Tables - 10 to 15).

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>900</b>	<b>47746</b>	<b>1745</b>	<b>37915</b>
China	12	598	208	9112
Bangladesh	19	1075	419	4387
UK	16	702	30	2831
Switzerland	-	-	100	2452
Australia	60	2647	60	2351
USA	344	14780	90	2273
Saudi Arabia	85	2389	90	1945
Spain	70	3574	41	1805
Argentina	++	5857	10	641
Brazil	++	8026	-	-
Other countries	294	8098	697	10118

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>429</b>	<b>24750</b>	<b>1144</b>	<b>13703</b>
Switzerland	-	-	100	2452
Uganda	8	177	76	2133
Spain	60	2740	41	1805
USA	144	3197	69	1560
Djibouti	44	165	44	960
Bangladesh	-	-	300	727
Kenya	8	419	67	660
Argentina	++	5857	-	-
Brazil	++	8026	-	-
Kuwait	38	1256	-	-
Other countries	127	2913	447	340

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>136</b>	<b>6835</b>	<b>237</b>	<b>8006</b>
Australia	60	2647	60	2351
Saudi Arabia	-	-	80	1760
New Zealand	20	899	20	777
Argentina	-	-	10	641
USA	40	2132	16	595
Oman	-	-	4	487
Yemen Republic	1	85	10	427
Mayanmar	-	-	20	366
UK	-	-	6	230
Spain	10	834	-	-
Other countries	5	238	11	372

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>335</b>	<b>16161</b>	<b>364</b>	<b>16206</b>
China	5	336	208	9112
Bangladesh	19	1075	119	3660
UK	16	702	24	2601
Chile	28	1193	2	312
USA	160	9451	5	118
Nepal	10	300	1	53
UAE	2	144	++	4
Saudi Arabia	80	2134	-	-
Canada	2	233	-	-
Congo, People's Rep.	3	209	-	-
Other countries	10	384	5	346

BORON MINERALS

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>788</b>	<b>30914</b>	<b>878</b>	<b>35950</b>
Japan	324	13614	406	14617
USA	212	10496	200	9306
Hong Kong	-	-	60	3490
Nigeria	-	-	44	2283
Mauritius	-	-	35	1970
Korea, Rep. of	54	2340	36	1413
Sri Lanka	33	665	17	592
Uganda	30	272	5	255
Bangladesh	18	606	20	187
Korea, D.P. Rep.of	18	782	-	-
Other countries	99	2139	55	1837

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>89</b>	<b>14499</b>	<b>341</b>	<b>34575</b>
Chinese Taipei/ Taiwan	61	8845	308	28471
Israel	5	1088	14	3539
Korea, Rep. of	1	284	12	1433
USA	-	-	7	1129
Yemen Republic	-	-	++	3
Netherlands	22	4282	-	-

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>63067</b>	<b>1017199</b>	<b>78625</b>	<b>1169576</b>
Turkey	24385	397772	29816	436700
USA	15281	270602	22292	370150
Argentina	7846	148692	5675	91526
Spain	1782	41787	2739	61832
Bolivia	7842	56136	7865	57279
Chile	3312	22974	8184	55009
China	756	26921	1052	45671
Slovenia	187	6762	319	12663
Germany	37	2270	199	12294
Belgium	172	9370	220	9280
Other countries	1467	33913	264	17172

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>23479</b>	<b>307278</b>	<b>29091</b>	<b>324289</b>
Argentina	7828	147841	5675	91526
Turkey	1648	26022	4404	60140
Bolivia	7842	56136	7865	57279
Chile	3312	22974	8184	55009
Spain	1782	41787	2252	49715
USA	147	3316	710	10592
Colombia	622	4245	-	-
Peru	24	586	-	-
UK	135	2080	-	-
Unspecified	120	1734	-	-
Other countries	19	557	1	28

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>35712</b>	<b>600661</b>	<b>46914</b>	<b>737521</b>
Turkey	20936	342464	24819	367638
USA	14435	251843	21230	347510
Spain	-	-	487	12117
UK	21	400	88	4405
China	102	1711	155	2914
Peru	-	-	30	1325
Germany	1	32	61	935
Malaysia	-	-	42	623
Argentina	18	851	-	-
Unspecified	159	2644	-	-
Other countries	40	716	2	54

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>3876</b>	<b>109260</b>	<b>2620</b>	<b>107766</b>
China	639	24744	897	42757
Slovenia	187	6762	319	12663
USA	699	15443	352	12048
Germany	36	2238	137	11331
Belgium	172	9370	220	9280
Turkey	1801	29286	593	8922
Finland	-	-	27	3740
Netherlands	18	2740	17	2223
UK	27	3792	5	545
Morocco	80	8275	-	-
Other countries	217	6610	53	4257

BORON MINERALS

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>9085</b>	<b>209111</b>	<b>6645</b>	<b>142708</b>
Turkey	5825	133407	3800	79929
USA	1013	25516	1843	41038
Chile	324	7155	475	9400
Argentina	936	22326	259	6039
Peru	349	8145	225	4772
China	585	10792	20	811
Sweden	1	21	20	587
Germany	10	206	2	81
Jordan	19	817	-	-
UAE	20	488	-	-
Other countries	3	238	1	51

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

Country	2006-07		2007-08	
	Qty. (t)	Value (Rs. '000)	Qty. (t)	Value (Rs. '000)
<b>All Countries</b>	<b>31</b>	<b>13643</b>	<b>5</b>	<b>2717</b>
USA	30	12174	5	2455
UK	++	520	++	133
Austria	-	-	++	96
Germany	-	-	++	33
China	1	914	-	-
Japan	++	35	-	-

## FUTURE OUTLOOK

Increased usage of ceramic tiles will keep consumption of boron minerals in the enamels, frits and glazes end-use high. 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 will enhance the demand of borax for the production of fibre glass.