InfoMine research group

The association of independent consultants
in mineral resources, metallurgy and chemical industry

Boron and Borates Market Research in the CIS

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Annotation

The report is devoted to investigation of current standing of market of boron products in the CIS and forecast of its development. The report is composed of 7 Sections, contains 106 Pages, including 19 Figures, 67 Tables and 2 Appendices. This work is a desk research. As information sources, we used data of Federal Service of State Statistics of Russia (Rosstat, FSSS of Russia), State Committees on Statistics of CIS countries, Federal Customs Service of Russia (FCS of Russia), State Customs Committee of Ukraine (SCC of Ukraine), railage statistics of Russia. Besides, data of sectoral and regional mass-media, yearly and quarterly reports of companies, as well as web-sites of enterprise-producers and consumers of boron products.

The first Section of the report presents data on world market of boron (reserves, production, prices).

The second Section of the report is devoted to description of boron deposits in the CIS.

The third Section of the report presents data on mining and production of boron in the CIS.

The fourth Section of the report presents data on current standing of producers of boron products in the CIS.

The fifth Section is devoted to foreign trade operations in boron products in Russia and Ukraine. In addition, it analyses export-import prices on boron acid, borax, calcium borate and other products.

The sixth Section of the report describes consumption of boric acid in Russia. The Section presents supply-demand balance of the product, sectoral pattern of consumption and its change, as well as current standing and prospects of development of the greatest enterprise-consumers.

The seventh Section of the report presents forecast of Russian boric acid market development (production, export, import and consumption) up to 2015.

Appendix presents addresses and contact information of enterprises, producing and consuming boron acid.

INTRODUCTION

Boron is a naturally occurring element that is found in the oceans, rocks, coal, shale, and some soils. It is widely distributed in nature, with concentrations of about 10 mg/kg in the Earth's crust (range: 5 mg/kg in basalts to 100 mg/kg in shales) and about 4.5 mg/liter in the ocean.

The most important commercial borate products and minerals are borax pentahydrate, borax, sodium perborate, boric acid, colemanite, and ulexite. Boron compounds of commerce in approximate decreasing order of usage are as follows:

Borax pentahydrate (disodium tetraborate pentahydrate): $Na_2[B_4O_5(OH)_4]x3H_2O$ ($Na_2B_4O_7$ x $5H_2O$)

Borax (disodium tetraborate decahydrate) $Na_2[B_4O_5(OH)_4]x8H_2O$ ($Na_2B_4O_7x10H_2O$)

Ulexite $NaCa[B_5O_6(OH)_6]$ x $5H_2O$ (Na_2O x $2CaO$ x $5B_2O_3$ x $16H_2O$)

Colemanite $Ca[B_3O_4(OH)_3]$ x H_2O ($2CaO$ x $3B_2O_3$ x $5H_2O$)

Sodium perborate tetrahydrate $Na_2[B_2O_4(OH)_4]$ x $6H_2O$ ($NaBO_3$ x $4H_2O$)

Sodium perborate monohydrate $Na_2[B_2O_4(OH)_4]$ ($NaBO_3$ x H_2O)

Boric acid $B(OH)_3$ (H_3BO_3)

Anhydrous borax $Na_2B_4O_7$ (amorphous) (disodium tetraborate)

Boron oxide B_2O_3 (amorphous)

Boron B.

Sodium perborates are persalts that are hydrolytically unstable because they contain characteristic boron-oxygen-oxygen bonds that react with water to form hydrogen peroxide and stable sodium metaborate ($NaBO_2$ x nH_2O). This hydrolysis reaction is the basis of the use of perborates as bleaches in detergents at high (70-100°C) temperature. At lower washing temperatures (25-70°C), activators are needed; these react with peroxide to give peracids, which are stronger oxidants and give bleaching effects at lower temperatures.

Boric ores basic application is production of boric acid, calcium borate, borax technical, boric fertilizers. The boric acid (B_2O_3 percentage - 56 %) is the basis for manufacture of many boron products: boric anhydride (B_2O_3 - 100 %), borides, perborates, boranes, fluoroboron compounds.

Economic deposits of borate minerals are rare and are usually found in arid desert regions with a geological history of volcanic and/or hydrothermal activity. Major world deposits are found in Turkey, the USA, Argentina, Russia, Chile, China, and Peru.

The most abundant boron mineral is tourmaline, an aluminium borosilicate that contains about 3.1% boron. It is not a practicable source of usable boron, as it is widely distributed as a minor component of rocks. Economic borate minerals include tincal, kernite, colemanite, and ulexite. The two largest producers of borate minerals in the world are the Turkey and USA. Further mining and production facilities exist in Argentina, Bolivia, China, Chile, Peru, and Russia. Most US production of borates occurs in California, where colemanite, ulexite, tincal, kernite, and brines are

processed. These minerals are also processed elsewhere in the world, as are ascharite, hydroboracite, datolite, etc.

Borates abound in industrial systems for two reasons. First, they're safe. Used for centuries, borates pose no risk to people, animals or the environment under normal handling and use. Even those who handle borates every day have experienced no adverse health effects. Second, they're versatile. In some applications, there is simply no substitute for borates. In other products and processes, their natural functions impart a wide range of performance, cost, environmental health and safety advantages. Main areas they affect: metabolism agent, bleaching agent, buffering agent, dispersing agent, vitrifying agent, inhibiting agent, flame-proofing agent, and neutron absorbing agent.

Metabolizing Effects – In certain organisms, borates can inhibit metabolic processes. This makes them useful in controlling insects, bacteria and fungi in everything from construction timbers to cosmetics.

Bleaching Effects – Another key chemical effect comes into play in laundry detergents and other cleaning products, where borates are important components in bleaching and stain removal.

Buffering Effects – The chemical properties of borates serve to balance acidity and alkalinity in many applications. Detergents, fireworks and film processing solutions all rely on borates for a stable pH.

Dispersing Effects – Borates are able to bond with other particles to keep different ingredients dispersed evenly and are used to control viscosity in paints, adhesives and cosmetics.

Vitrifying Effects – Borates modify the structure of glass to make it resistant to heat or chemical attack. Similarly, they facilitate the production of ultra-thin LCD screens, functional fiberglass and beautiful ceramic tiles and glazes.

Inhibiting Effects – Borates interact with surfaces containing iron to form a coating that protects the metal from corrosion. They are important additives in products as diverse as antifreeze and aerosol cans.

Flame-Proofing Effects – Combined with zinc, borates are used to retard flames and suppress smoke in polymers. Borates also act as a flame retardant in cellulose insulation.

Neutron-Absorbing Effects – Borates absorb neutrons in applications ranging from nuclear containment shields to treatments for cancer.

While borate applications number in the thousands, chief among them are:

Agriculture: Boron is an essential micronutrient for plants, vital to their growth and development. Without sufficient boron, plant fertilization, seeding and fruiting are not possible. On every continent of the world, crop yields and food quality are diminished due to insufficient boron concentrations in the soil. These deficiencies can be corrected with borate fertilizers. In areas of acute deficiency, borates can increase crop yields by 30 to 40 percent.

Ceramics: Borates have been an essential ingredient in ceramic and enamel glazes for centuries, integral to affixing glazes or enamels, and enhancing their durability and luster. Borates now are gaining acceptance as an essential ingredient in

ceramic tile bodies, allowing manufacturers to use a wider range of clays, heightening productivity and decreasing energy usage.

Detergents and Personal Care Products: Borates enhance stain removal and bleaching, stabilize enzymes, provide alkaline buffering, soften water and boost surfactant performance in detergents and cleaners. Their biostatic properties control bacteria and fungi in personal care products. New trials demonstrate that adding borates to laundry soap bars significantly improves their cleaning action and reduce levels of dirt redeposition.

Diet: Not surprisingly, people get the boron they need by eating plant-derived food. Studies indicate that people in a wide variety of cultures consume one to three milligrams of boron per day through a combination of foods and drinking water in their local diets. Although it has not been proved yet that humans need boron to live, there is almost universal agreement in the scientific community that boron is nutritionally important to maintain optimal health.

Fiberglass: Borates are an important ingredient in both insulation fiberglass – which represents the largest single use of borates worldwide – and textile fiberglass, used in everything from circuit boards to surfboards. In both products, borates act as a powerful flux and lower glass batch melting temperatures. They also control the relationship between temperature, viscosity and surface tension to create optimal glass fiberization.

Glass: Borosilicate glass is the foundation for all heat-resistant glass applications and the myriad products they make possible – from cathode ray tubes to Pyrex® cookware. Borates increase the mechanical strength of glass, as well as their resistance to thermal shock, chemicals and water.

Polymer Additives: Zinc borates are used primarily as a fire retardant synergist in plastics and rubber applications. They also can function as smoke and afterglow suppressants, anti-tracking agents, and can be used in polymers requiring high processing temperatures. Zinc borates can be found in polymers ranging from electrical parts and automobile interiors to wall coverings and carpeting.

Wood Treatments: Borate-treated wood is on the rise as a safe and long-lasting method to protect homes and other structures from wood-destroying organisms. Borate-based preservatives can be used to treat solid wood, engineered wood composites and other building materials like studs, plywood, joists and rafters. Borates prevent fungal decay and are deadly to termites, carpenter ants and roaches – but are safe for people, pets and the environment.

An approximate pattern of world demand or borates is as follows:

- insulation fiberglass, textile fiberglass and heat-resistant glass (43% of world demand);
- detergents, soaps and personal care products (17% of world demand);
- ceramic and enamel frits and glazes, ceramic tile bodies (12% of world demand);
- agricultural micronutrients (5% of world demand);
- wood treatments, polymer additives and pest control products (23%).

Boron nitride and carbide are used for manufacture of abrasive and semi-conductor materials, high-melting super-hard alloys, as neutrons absorbers in nuclear reactors.

Besides, boron is used in manufacture of permanent magnets on the basis of a three-component alloy of neodymium, iron and boron; electric transformers, in personal stereo systems and players for compact discs; scanners. Perspective area is manufacture of the amorphous ferric-silicon-boric alloys used for manufacturing transformer cores.

More than 230 boric minerals are known in nature. The largest part belongs to the borate class, as well as borosilicates and boron-aluminosilicates, which refer to silicate class and are less widespread. All of them are boron-oxygen compounds, and only four boron minerals belong to oxygen-free compounds - fluorides. Among boron minerals only about 20 have practical value. Mainly they are calcium borosilicates and Mg, Ca, Na, K borates.

Based on formation conditions the boron deposits are subdivided into endogenous, endogenous-exogenous and exogenous.

Most of Russian/CIS payable reserves of boron-containing ores falls to *Endogenous* deposits, associated with calcium and magnesian boron-containing skarns. In the deposits, the following boron-containing minerals dominate: datolite ($CaB(OH)[SiO_4]$), danburite ($CaB_2[Si_2O_8]$); other boron minerals are presented by suanite ($Mg_2B_2O_5$), kotoite ($Mg_3(BO_3)_2$), ludvigite-gulsite ($((Mg,Fe^{2+})_2(Fe^{3+},Al^{3+},Sn^{4+},Ti^{4+},Mg)[BO_3(O_2)]$), ssaibelite ($Mg_2OH[B_2O_4(OH)]$), etc.

A group of *endogenous-exogenous* deposits is presented by volcanogenic - sedimentary deposits, formed in low-flowing and undrained lakes located near volcanoes in arid climate conditions. Boric minerals are represented by borates of Ca, Na and Na-Ca: colemanite, tincal, konite, borax, kernite, etc.

Exogenous deposits of boron are connected with deposits of marine potassium-magnesium salts (halogenic) or with processes of their weathering (eluvial). The basic boron minerals are kaliborite, hydroboracite, preobrazhenskite, boracite, ulexite, ascharite, etc. In Russia, exogenous deposits have no industrial value.

Besides the ore deposits, boron sources are also found in mineral waters and reservoir waters of oil and gas deposits.

Based on formation condition, mineral composition, technological properties the boric ores are subdivided into borosilicate, borate, complex borate - magnetite and tin - boric.

The largest and richest sources of borate ores in nature are connected with deposits of volcano-sedimentary type, which provides 90 % of global boron mining. The ores are easy-dressable, complex - containing also bentonites, zeolites, sulfur, antimony, strontium, halite etc., which are also extracted from them. In Russia they have not been found as yet.

In the Russian Federation borosilicate and complex borate - magnetite ores, connected with endogenous deposits of skarn type, are of the basic commercial value.

I. Brief characteristics of world market of boron (reserves, production, prices)

I.1. Reserves

The main reserves of borates in the world are available in Turkey and USA. USGS estimates world reserves of borates of 309 mln t (ignoring Russia and Kazakhstan), whereas National Boron Research Institute (Turkey) gives the value of 756 mln t (Table 1). The difference is mainly connected with different estimation of boron-containing ore reserves in Turkey; in this situation we consider own Turkish data on the country reserves to be more reliable, and, thus, the world reserves estimate of National Boron Research Institute seems us more reliable too.

Table 1: Reserves of boron-containing ores inn the world, mln t*
(in equivalent of B_2O_3)

Country	**Total reserves**	
	Data of US Geological Survey	*Data of National Boron Research Institute (Turkey)*
Turkey	150	563
USA	80	80
China	47	36
Chile	n. a.**	41
Bolivia	n. a	15
Peru	22	22
Argentina	9	9
Iran	1	n. a.
Total	**309**	**756**

* - without CIS ** n. a. means "data are not available"
Source: InfoMine on the basis of data of US Geological Survey (USGS) and National Boron Research Institute (Turkey)

The Kramer deposit **(USA),** located in the center of Mohave Desert approximately 160 km to the northeast of Los Angeles, is one of the largest boron deposits of the world. From the beginning of the operation (1926) and by present time the deposit is considered to be the leading world supplier of boron raw material.

The deposit is confined to lake sediments of Miocene period. The main ore body of the deposit lying among blue-grey clay slates at a depths from 40 (northern and western flanks) down to 340 m (southern flank), is presented by a stratum lode of thickness from 24 up to 90 m (about 45 - 60 m in average), covering 2 km^2 area. It consists of concordant layers and sublayers of thickness up to 10 cm as well as lenses, tumors and inclusions of borax, kernite, tincalkonite; syrlesite, ulexite and proberite are less abundant. These layers and sublayers are divided by thin layers of montmorillonite clay and volcanic tuff. At rich ore sites, average contents of B_2O_3 constitutes 25-30 % and more. The ores are mined in the quarry, then are crushed, sieved and dissolved to obtain saturated brine with its following filtering. As a result

of this liquid crystallization, refined crystals of borax decahydrate and pentahydrate are formed.

In ***Turkey*** the largest boric resources deposit known now is ***Kyrka (Sarikaya)***, located in province Askishekhir in 240 km from Ankara. It is confined to Pliocene lake sediments. Lake carbonate - clay sediments with sublayers of volcanic ash material occupy the area of about 10 km^2, lying on volcanic basement, composed of basic and acid tuffs and lavas. The lake sediments are completely overlapped by massive neogenous limestones several ten meters thick. Now in the ore field Kyrka about 450 thousand tpy of mainly sodium-borate ores are mined; they are delivered to the plant in Bandirma, where various boric compounds are produced including boric acid, borax decahydrate and pentahydrate.

In South America, large boron reserves are available in **Argentina**: in Salta Province (deposits ***Tincalayu*** and ***Sijes***), as well as in Province Zhuzhui (ephemeral lakes ***Salars Cauchari*** and ***Diabillo***). The main minerals here – colemanite, hydroboracite, kernite, tincal and ulexite.

China also has large potentiality in boron minerals mining – above 100 boron deposits have been discovered in the country (in 14 Provinces). 80% of the deposits are located in north-eastern Lyaonin Province and western Tsinhai Province.

Borate deposits are also available in a number of other countries, for instance in ***Bolivia***, ***Chile***. Recently large boron deposits were discovered in ***Kosovo***.

In Table 2, the main boron minerals occurring in its payable deposits are shown.

Table 2: The main boron minerals, occurring in its payable deposits

Group	Mineral	Chemical composition	Content of B_2O_3, %
Sodium borates	Boric acid (sassolite)	$B(OH)_3$	56,4
	borax (tincal)	$Na_2B_4O_7 \cdot 10H_2O$	36,5
	tincalkonite	$Na_2B_4O_7 \cdot 5H_2O$	47,8
	kernite	$Na_2B_4O_7 \cdot 4H_2O$	51,0
Sodium-calcium borates	ulexite	$NaCaB_5O_9 \cdot 8H_2O$	43,0
	probertite	$NaCaB_5O_9 \cdot 5H_2O$	49,6
Calcium borates	inyoite	$Ca_2B_6O_{11} \cdot 13H_2O$	37,6
	colemanite	$Ca_2B_6O_{11} \cdot 5H_2O$	50,8
	pandermite	$Ca_4B_{10}O_{19} \cdot 7H_2O$	49,8
Calcium (potassium)-magnesium borates	kurtchatovite	$Ca_6Mg_5MnB_{12}O_{30}$	40,7
	sakhaite	$Ca_{12}Mg_4(CO_3)_4(BO_3)_7Cl(OH)_2 \cdot H_2O$	18,5
	kaliborite	$KMg_2[B_3O_3(OH)_5]_2B_5O_6(OH)_4 \cdot 2H_2O$	57,0
	hydroboracite	$CaMgB_6O_{11} \cdot 6H_2O$	50,6
Magnesium Borates	boracite	$Mg_3B_7O_{13}C$	62,2
	ssaibelite	$Mg_2B_2O_5 \cdot H_2O$	41,4
	kotoite	$Mg_3(BO_3)_2$	35,5
	suanite	$Mg_2B_2O_5$	46,3
	preobrazhenskite	$Mg_8[B_5O_7(OH)_4]_2 \cdot H_2O$	51,2
	ludvigite	$(Mg,Fe)_2Fe(BO_3)O_2$	12-17
Borosilicates	datolite	$Ca_2B_2(SiO_4)_2(OH)_8$	21,8
	danburite	$CaB_2(SiO_4)_3$	28,3
Boroaluminosilicates	axinite	$Ca_2(Mg,Fe)Al_2BSiO_4O_{15}(OH)$	5-8
	tourmaline	$(Na,Ca)(MgA1)_6[B_3A1_3Si_6(O,OH)_30]$	7-12

Source: scientific-technical literature

I.2. Mining and production

Volume of world mining of boron minerals steadily increases in latest years (Table 3), and only in 2002 slight decline in the mining of boron-containing ores took place (by 3.3% year-on-year). From preliminary estimation of USGS the mining of borates in 2007 reached 4.98 mln t, slightly above the 2006 level.

Table 3: Mining of boron-containing ores in the world in 1998-2008, kt*

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Turkey											
USA											
Argentina											
Chile											
China											
Bolivia											
Peru											
Iran											
Germany											
Total											

* - ignoring the mining in the CIS

Source: USGS (2008- estimate)

The bulk of world boron resources is mined in Turkey and USA - around 70% of the world total in 2006-2008.

Turkey.

State-owned Eti Mine Works General Management, monopoly producer of boron products at domestic market and great exporter, actively penetrates into European markets. After a plant on production of boric acid with capacity of 100 kt per year was built and launched in 2004 in Emet city Turkey became the greatest producer of boric acid in the world. The company owns 5 enterprises on mining and processing of boron ores (Table 4).

Table 4: Eti Mine capacities on boron products by plants

Location	Mined resources	Capacity, kt per year	Products	Capacity, kt per year
Bandirma	Colemanite Ulexite		Sodium tetraborate decahydrate	
			Sodium perborate	
			Boron oxide	
			Boric acid	
Emet	Colemanite 28-30% B_2O_3		Boric acid	
			Purified colemanite	
Kirka	Tincal		Purified sodium tetraborate pentahydrate (Etibor-48)	
Bigadic	Ulexite Colemanite 29-31% B_2O_3		Concentrated colemanite and ulexite	
			Grinded colemanite and ulexite	
Kestelek	Colemanite 29% B_2O_3		Concentrated colemanite	

Source: "InfoMine " on the basis of Eti Mine data

In 2007 Eti Mine produced 2.13 mln t concentrated ores and manufactured 1.09 mln t boron-containing products from them. In 2008, from preliminary data, 2.25 mln t ores were mined.

Europe is traditional market for Eti mine, and in the latest 5 years the company supplies to the region increased, including at the expense of supplies to Russia. Eti Mine supplies to Europe, including china, also significantly increased. At the same time, Eti Mine decreased supplies to USA and to domestic consumers.

One of new projects of the company became launching a line of calcined borax manufacture in 2007. The company will produce around 200,000 tpy of the product, which is expected to find its market in sector of insulation material manufacture.

In nearest future Eti mine plans to start zinc borate production. The project is scheduled on 17 years, from 2005 to 2017, and at the first stage, production volume of 10,000 tpy is planned.

USA

In the United States two companies - **US Borax** and **Searles Valley Minerals** are engaged in manufacture of boron products.

Company **Searles Valley Minerals** manufactures borax (decahydrate, pentahydrate, anhydrous) and boric acid from brines of Serlz Lake in St. Bernardino. The company brand is “Three Elefants”. At present time, controlling interest in the company is owned by Indian company Nirma Ltd.

US Borax is a daughter company of **Rio Tinto Minerals** (London), being, in turn, a part of Rio Tinto Group – Australian-British concern. Rio Tinto Minerals was found in 2006 by merger of companies Rio Tinto Borax, Luzenac Talc and Dampier Salt.

US Borax develops the world's largest borate deposit located in California. The US Borax has branches practically worldwide: Borax Argentina, Borax Espana, Borax Rotterdam, Borax Italia, etc.

The US Borax share in the world boric acid market constitutes above 40%. The company sales the product under brand name Optibor. The main plant on boric acid manufacture is located in Boron town (California), the plnt capacity is 360,000 tpy. The plant also produces aunhydrous borax and boron oxide. Besides the products, US Borax produces zinc borates at plant in Wilmington (Northern California – 12,000 tpy in average.

Experts consider the US Borax products are the most pure in the world, and the production is the most economically and environmentally efficient.

From USGS data, in 2008 USA exported 260 kt boric acid (248 kt in 2007) and around 470 kt sodium borates (446 kt in 2007). The main country-importers were Netherlands, China, Canada, Spain, Malaysia, Japan, India.

As for USA imports, the bulk of it belongs to ores: ulexite (90 kt in 2008) and colemanite (27 kt in 2008), as well as boric acid (around 65 kt in 2008).

India

There are rather many boron product manufactures in India. World-known producer is Borax Morarji, found in 1963, its capacities are 25 kt of borax, sodium metaborate and ammonia pentaborate plus 8 kt of boric acid per year. The main domestic competitors are Gujarat Boron Derivatives Pvt Ltd, National Peroxade Ltd and Indo Borax & Chemicals Ltd. By 2009-2010 in region Khamman a plant on boric acid production is to be built under the aegis of Nuclear Power Agency of India

Chile

Company Quiborax develops the ulexite deposit in Salar-de-Surire in the north of Chile with reserves of several million t of the mineral, containing 25-32 % of B_2O_3. Its productivity is 600 thousand t of the ores per year. In the latest years ***Quiborax*** invested $17 million in the modern technology and automation of the plant to upgrade processing of boron resources.

In 2004 in northern part of Chile in 85 km from Kalaman (Salar de Tara district) a new colemanite mine was launched. It produces:

- Granulated ulexite 32 % B_2O_3 (10 % B) for preparation of dry plug-back mixtures and for agricultural needs;
- Ground ulexite 30-40 % B_2O_3 with grain size below 1 mm;
- and concentrate of 50-60 % B_2O_3 with grain size below 0.5 mm.

Argentina

Borax Argentina S.A. is the leading Argentina borates manufacturer and their largest exporter to the USA. Borax Argentina mines borates at three deposits: Tinkalaya and Sidzes in Salta province and Povinir in Judjui province and yields around 100 thousand t of borates per year. The main products – colemanite, hydroboracite, kernite, tincal and ulexite. ***Tinkalaya*** deposit was discovered in 1976 and is the largest in Argentina, developed by open-cut mine. Its sizes: length – 1.5 km, width - 500 m and depth - 100 m. Clay overburden averages 50 m.

In 2005 in Olakapato (Salta province) a new ulexite mine was launched. The mined ulexite is delivered to Saltato (180 km from the mine) where the boric acid production plant with the capacity of 4800 t per year was erected. Company Rio Tinto Borax has invested $2.6 million in this plant construction that started in August 2002, and the boric acid manufacture started in 2003. The second phase of the plant construction which will increase the capacity up to 12 000 t per year is in progress.

The U.S. Borax's Salar del Rincon Company has developed the project of borates extraction from brine of salt lakes. The lake where borates are extracted now is in northwest of Argentina at altitude of 3700 m above sea level.

Bolivia

Contents of B_2O_3 in ulexite ores of Kimika del Borax deposit, Rio Grande, constitutes 32-36 %, and these ores have very low arsenic contents. Extraction is accomplished by Chilean company Quibora, volume of ulexite extraction constitutes approximately 25 thousand t per year. Kapina deposit with 25 - 32% contents of B_2O_3 is not exploited (its reserves are 10 million t of low-arsenic ulexite). Quiborax has a

plant to manufacture boric acid with the capacity of 35 thousand t per year in El Aguila, 60 km from Arica.

Chilean Quiborax was also involved in ulexite extraction at Salarde Yumy deposit. However in June 2005 the Bolivian Ministry of hydrocarbon and mineral resources annulled the company licenses on the resources mining. The company submitted the claim against the Bolivian government. The loss estimation was carried out by the International Center on Settlement of Investment Disputes of the World Bank.

I.3. Consumption

According to World Review, since 1970 world consumption of boron was doubled. By 2008, the consumption of borates reached 1.6 mln tonnes. At present time, the main end-use of boron compounds is glass industry, first of all, production of fiberglass. For instance, North-American glass industry consumes around 44% of world supply of boron.

Detergents and soaps are the second greatest end-use of borates. The European market of detergents consumes more than 240 thousand t of sodium borate per annum. However, forthcoming restricting content of boron in drinking water in EC by 2013 may result in some depressing of boron use in detergents.

In 2007, USA consumed 400 kt of boron-containing products (in equivalent of B_2O_3). Pattern of consumption of borates and other boron compounds in USA is as follows: glass and ceramics production – up to 70%, detergents and soaps – 5%, fireproof compositions – 4%, agriculture – 2%, other – 19%.

Until recently, pattern of consumption of borates and other boron compounds in Turkey was as follows: glass industry – 40%, ceramic industry – 15%, and detergents and bleachers – 10%. However, in 2007 producers of detergents decreased considerably boron products consumption owing to strengthening standards on boron use in their products. The pattern in 2007 became as follows: glass industry – 43%, ceramic industry – 40%, detergents and bleachers – 2% and the rest belonged to other end-uses.

Notice that only 7% of the products produced are consumed at domestic market, whereas 40% are exported to Europe and 25 % - to North America.