TECHNICAL DESCRIPTION
OF BALKHASMED COPPER COMBINATE.

(to become part of the information memorandum
to selected prospective investors**)**

10 December 2003 18:34

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1. COPPER IN GENERAL IN KAZAKHSTAN

Copper resources and copper production in Kazakhstan represent 30% of the former USSR's copper resources and production. Copper resources are located in 74 orebodies. Thirty two of these, are major orebodies; they account for almost 90% of Kazakhstan' s total copper resources. Thirty five percent are resources that are still in presently operating mines; 11% are currently under development; 48% are in proved orebodies to be developed and 6% are under exploration. Prevailing genetic types of copper deposits are copper porphyry orebodies (42%), skarn and sediment hosted orebodies (29%), while chalcopyritic types form the balance.

There are two major producers of refined copper in Kazakhstan:

Balkhash copper combinate, built in the late 1930s.

Jezkazghan copper combinate, built in the late 1950s with effective production in the 1970s.

Their respective annual smelting and electrolytic refining capacity in tonnes of copper metal are as follows, as reported to the international copper directory in 1993:

	smelting (blister)	refining (cathodes)
Balkhashmed	200 000	300 000
Jezkazghan	220 000	300 000

The higher capacity of electrolytic refining of these combinates, compared to smelting, is because they are capable of refining blister copper and copper mattes produced by other metallurgical combinates in Kazakhstan and in the ex-USSR now the CIS (East Ural).[1]

Blister capacity at Balhashmed is presently 120 000-140 000 tpa Cu mainly because of low grade of concentrates and constraints related with acid production[2]:

Other suppliers of copper raw materials to Balkhashmed are:

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[1] Supported by adequate documentation in the data room: origin of blister copper and copper matte in Kazakhstan; distribution of total copper supply to the complex over the past 5 years.

[2] *initially the complex was to receive a significant amount of copper concentrates at >30% Cu, from Jhezkazgan mine (ore at approx. 2% Cu); after the start of Jezkazghan copper complex, the latter mine was specialised for Jhezkazgan. So Balkhashmed had to rely mainly on its Kounrad mine which is lower in Cu grade and correlatively higher in sulphur. Lower Cu grade ores affect the productivity of equipment (furnaces and converters) and creates greater environmental problems due to the disposal of sulphuric gases. With the enforcement of more stringent environmental controls and penalties by the Government of Kazakhstan, both of these factors limit the production of blister to approx. 120 000-140 000 t Cu.*

- East Kazakhstan copper chemical combinate, (copper matte),
- Irtych and Leninogorsk polymetallic combinates (blister),
- Zyryanov lead zinc combinate (copper matte),
- Zhezkent and Zhayrem mining and beneficiation combinates (concentrates).

2. BALKHASHMED COPPER COMBINATE

2.1 LOCATION, NAME AND ADDRESS

Name and address: Balkhashmed Joint Stock Company

78210 Balkhash, Lenina Str 1

Dzhezkazgan Oblast; Kazakhstan[3]

Location: 47°00N, 74°30E. The production units of Balkhashmed Combinate are situated in central Kazakhstan, on the east of Bertys bay, in the middle of the northern shore of lake Balkhash.

2.1.1 HISTORY OF THE COMBINATE

Balkashmed copper combinate is the most important non ferrous metals producer in Central Asia. In the past, it played a leading role in non ferrous extractive metallurgy in the ex-USSR, both for its level of production and for innovative technological developments; for example extraction of molybenum from sulphides and oxides in Kounrad ores with low Mo grade, new technology for smelting low grade copper ores with high sulphur content (Vanukov furnace), extraction of rhenium salts from Kounrad Mo semi-products, and more recently a modern precious metals refining plant (Au, Ag, Se, Rh, platinoids). These innovations, successfully implemented over the years, amply demonstrate that Balkhashmed has technological know-how and experience.

The combinate was built in the late 1930s and was to be based on the development of Kazakh copper mines including Jhezkazgan high grade copper mine and the nearby Kounrad copper-porphyry. Black copper was first produced in 1938 in a small plant located on the opposite side of the bay, east of the present complex. Further expansion of the combinate was achieved after world war II. Maximum historic production was achieved in 1973, with a refined copper output of 308 000t (cathodes). The last normal year of production was 1989 with 230 000t of refined copper. After the disintegration of the USSR, blister and refined copper production decreased and reached minimum level in 1991; since then, production is gradually increasing again; production of refined copper was 138 000t in 1993 and 135 250t in 1994.

The figure and table below show the main parameters of operation of Balkhashmed since 1989, and since the disintegration of the USSR.

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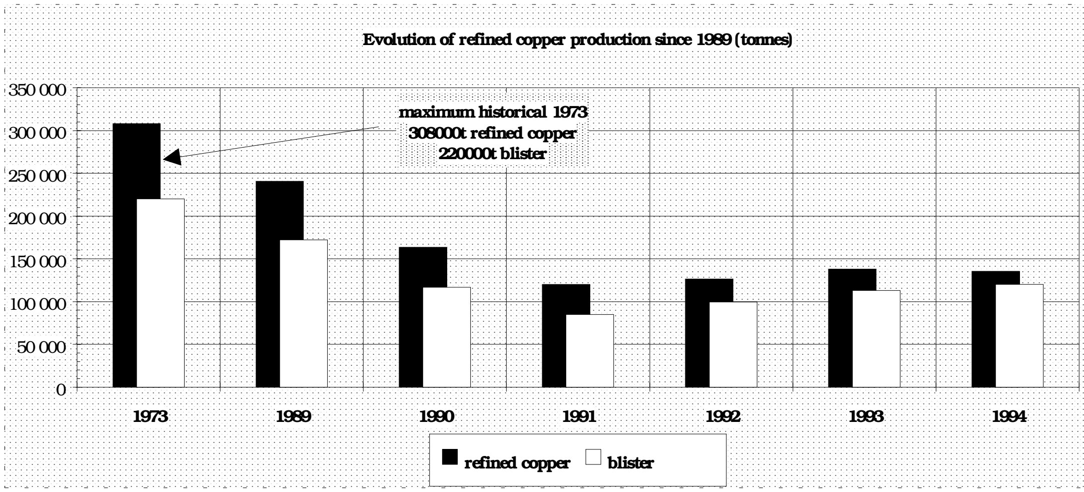
[3] Supported by adequate documentation in the data room: acts, decrees of incorporation, etc.



Years	1973	1989	1990	1991	1992	1993	1994
Productions							
Refined copper (t)	308 165	240 788	163 372	120 023	126 623	138 045	135 247
Blister copper (t)	220 000	172 000	116 700	84 922	99 506	113 022	120 000
Gold in slimes (kg)		13 631	11 714	8 518	10 155	8 655	7 220
Silver in slimes (kg)		267 300	261 545	158 418	143 760	127 328	112 113
M US$ Cu (*)	612	478	324	238	251	274	268
M US$ Au+ Ag (*)		192	169	119	135	116	98
% add on Au,Ag		40%	52%	50%	54%	42%	36%
rolled products (t)		35 205	35 054	35 247	16 900	10 750	6 472
Wire bars (t)		52 031	48 321	52 046	23 419	6 753	1 070
Wirebars on toil basis						12 320	6 696
Total transformation plant (t)		87 236	83 375	87 293	40 319	29 823	14 238
Sulfuric acid (t)	236 953	250 200	170 608	42 900	108 233	54 229	88 384
Metal recoveries %							
Up to blister copper %		95.5%	95.8%	93.7%	94.5%	95.2%	94.5%
Gold in slimes %		93.9%	89.6%	84.1%	89.2%	96.0%	94.6%
Silver in slimes %		96.7%	97.7%	93.4%	96.1%	98.4%	97.1%
Sulfur recovery for acid %		32.9%	30.6%	7.8%	25.0%	8.5%	17.2%
Cu recovery in flotation plant %		82.6%	82.1%	80.5%	76.0%	72.6%	75.7%
(*) on the basis of reference long term prices 0.9 $/lb Cu, 350 $/oz Au and 4.1 $/oz Ag							

It should be noted that the add-on value for gold and silver, based on reference long term market prices (0.90US$/lb Cu, 350$/oz Au and 4.1$/oz Ag), is of the order of 35-40%. Most of the gold results from the smelting, together with copper concentrates, of auriferous ores and concentrates. These materials, produced by mines and concentrators which are independent from Balkhashmed, contribute to the needs of SiO_2, iron oxides, and more generally fluxes, in the charge, necessary to form and separate metal from slag. The major part of the gold and silver is therefore purchased from the suppliers of raw material i.e. mines and concentrators.

2.2 CLIMATE, FLORA AND FAUNA

The climate of the region is continental with moderate rainfall throughout the year: hot in summer, cold in winter with permanent snow from mid November to end of February. In July-August, the hottest months, temperatures are: minimum 15°, maximum 30°, average 23.2°C. In January-February, the coldest months, temperatures are: minimum -35°, maximum about 0°C average -14°C. Average daily temperature is presented according to long term observation of Balkhash meteorological station (A.P Agarkova: Month Climate Characteristics of Kazakh SSR; Leningrad 1975 p 144-167). In winter, the region is under influence of the Siberian high pressures. Lake Balkhash is frozen from mid December to end of April. Precipitation in the area is 127 mm (same source p.7-50)[4].

The vegetation of the region is that of the semi-desert, with grass and small shrubs. Trees grow only near water accumulatons. Fauna is represented by small animals, rodents (desert rats, suslicks, etc.), hares, bats, carnivorous mammals (wolves, foxes etc.). Typical representatives of hoofed mammals, saiga antelopes, are not very common nowdays. Steppe and desert singing birds (passeriformes), birds of prey (eagles and falcons) are typical inhabitants of the region, as well as waterfowl (along the lake), such as ducks, gulls etc.

The main source of water flowing into lake Balkhash is the Ily river that drains water from the Tien Tshan mountains east of Almaty. Lake Balkhash is shallow water (max depth 6m), with salted waters (due to salt rocks, natrium) east of Balkhash and non salted waters west. The lake warms up very quickly after the thaw, and in June-July temperatures are well above 20°C. As the lake dries up, the shores are covered with salt.

2.3 COPPER AND PRECIOUS METALS SOURCES OF SUPPLY

In 1994, the copper metal supply of the combinate is assured by different sources [5]:

- approx. 25% by own resources: there are two open pit operating mines (owned and operated by Balkhashmed): Kounrad (15 km NE) and Sayak (200 km E). These mines supply by rail, approx. 25% of the copper requirement of the combinate (23.7% in 1994). This is ore at mean grade of approx. 0.45% Cu (Kounrad 0.35%, Sayak 0.60%) which is concentrated at Balkhashmed concentration plant by milling and flotation. The mean grade of concentrates produced is approx. 14-16% Cu
- the remaining 75% of the copper requirement comes from other sources:

[4] Supported by data in the data room: weather statistics from the airport station; environmental impact studies, etc.

[5] Supported by a list of copper, supplies by sources, during the past 5 years (origins, quantities, Cu% and others, prices, transport conditions and prices, etc.).

⇒ in Kazakhstan (28.2% in 1994)

⇒ and from outside Kazakhstan:

* Mongolia (Erdenet 36.7% in 1994),
* Chile (7% in 1994).[6].

Mongolian concentrates are brought for custom smelting by rail in containers, through Mongolia, Russia (Kouzbass); they are delivered CIF at the Mongolian border, shipped by rail through Russia at a cost equally shared by Balkhashmed and Erdenet, and shipped by rail in Kazakhstan at Balkhashmed's cost.

Chilean concentrates are brought for custom smelting to Balkhash by a trader, in rail cars; they are delivered by ocean vessel CIF Baltic port and from there shipped by rail through Russia at Balkhashmed's cost.

The copper grade of concentrates imported from outside Kazakhstan is higher, between 20% (Mongolia) and 30-35 % (Chile). Imported concentrates from distant sources require higher grades Cu to reduce the impact of transport costs.

The high grade of concentrates imported from Mongolia, and more particularly Chile, contributes in increasing the average grade of Cu of the charge to the furnaces, with favourable effect on productivity and unit production of the smelters.

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6 *The purchase of copper concentrates that are not custom smelted is transacted on the basis of formulas which are in principle as follows:*

The smelter pays from 92% to 95% of the copper content at current LME market price, with a minimum grade deduction of 1 to 2%, less an agreed amount for smelting and refining charges, in US$/t of dry concentrate for smelting and US$/lb Cu for refining.

In addition to copper, the smelter pays for the precious metals content (Au and Ag) of the concentrates, according to similar formulas.

gold: pay 90% of the gold with a refining charge of X US$/oz

silver: pay 95% of the silver with refining charge of Y US$/oz

(the smelting charge is already paid for in the copper formula).

Alternatively and more frequently, the purchase formula combines the recovery yield, the minimum grade deduction and the smelting and refining charges, and Balkhashmed pays for X% of the metal content e.g. 65-70%.

In 1994, overall, the average Cu grade of concentrates fed to the smelters was approx. 20% Cu.

2.4 CAPACITY OF PRODUCTION OF THE SMELTER REFINERY

The nominal capacity of the combinate was initially 200 000t/annum in blister and 300 000t/annum in electrolytic refining (cathodes). As indicated above, Balkhashmed purchases blister copper from outside (Irtych rare metals Combinate and other metallurgical plants in Kazakhstan) in order to meet the difference between smelting and refining, and therefore to optimise the use of its electrolytic refinery.

Considering an availability of blister purchased from outside of the order of 20 000-40 000 t Cu, the capacity of the combinate in refined copper, today, is of the order of 160 000-180 000 t Cu.

2.5 PRODUCTS OF THE SMELTER REFINERY

The main product of the combinate is electrolytic copper cathodes. Refined copper is a high-grade product known as M0K, under Kazakh specification (minimum 99.97% Cu). This is due to the quality of the concentrates available to Balkhashmed and to the absence of electrolyte bleeders in the electrolysis cells. Nevertheless, MOK cathodes are competitive and sell on the international market. The higher quality cathodes are MOOK which are eligible as LME grade A quality. Balkhashmed can produce about 10-15% of MOOK quality by selecting ores with minimum impurities and processing by campaigns. With some investment in the electolytic unit (bleeding system on the cells), the % of MOOK could be significantly increased.

MOK quality cathodes can be defective with regard to smoothness of surface, i.e. with presence of granules. Such cathodes are designated as grade M1K; they are produced in small quantities and are not marketed in export sales. They are either sent to the transformation plant or scrapped and recycled to the anode furnace.

Quality characteristics (chemical composition) of MOOK, MOK and M1K grades as per Kazakhstan standards are given below.

%	MOOK	MOK	M1K
min Cu	99.99%	99.97%	99.95%
max Bi	0.03%	0.05%	0.10%
max Sb	0.04%	0.10%	0.20%
max As	0.05%	0.05%	0.20%
max Fe	0.10%	0.10%	0.30%
max Ni	0.20%	0.10%	0.20%
max Hg	0.05%	0.20%	0.30%
max Sn		0.10%	0.20%
max S	0.15%	0.20%	0.40%
max O2	1.00%	1.50%	2.00%
max Zn		0.10%	0.30%
max P	0.15%	0.10%	0.20%
max Ag	0.20%	0.20%	0.30%

By-products of the electrolytic refining process are electrolytic slimes containing gold, silver, and other rare metals (Se, Te, Rh, platinoids etc.). The add-on value of recoverable precious metals vis à vis copper is of the order of 35-40%. Electrolytic slimes are first treated in a hydro-metallurgical unit of the combinate and then sent to precious metals refining plants, independent of Balkhashmed, at Chimkent and Ust Kamenogorsk. However, a precious metals refining plant is under construction, supplied by Boliden of Sweden (Contech) and entirely financed by own resources of Balkhashmed. It is expected to be ready by the end of this year 1995. It will then be possible to produce fine gold, silver and other precious metals, on the site of Balkhashmed combinate itself.

Hydrous copper sulphate and sulphuric acid are also produced, the former as a by-product of the electrolytic refining of copper, the latter as by-product of the treatment of sulphuric dioxide gases produced by the smelters and more particularly by the converters.

Molybdenum and magnetite concentrates were also produced in the concentration plant (selective flotation of copper, molybdenum and magnetite minerals). Since the disintegration of the USSR, these productions have been discontinued, but they can be resumed, if there is demand from the market.

Part of the production of copper cathodes is transformed on site in a metal transformation plant into rolled products (plates and strips) and wire bars of copper and various copper alloys (Ni, Zn, etc.). There is also a small magnet wire unit of 500 tpa capacity. The transformation plant is integrated in Balkhashmed Combinate, but it is managed as an independent enterprise. Present nominal capacity is 84 000 tpa of transformed products (32 000 t rolled and 52 000 t of wire-bars).

An expansion and modernisation program is presently underway which will increase rolling capacity to 75 000 tpa, modernise wire-bar production with a capacity of 40 000 tpa, increase and modernise magnet wire capacity of production to 7 000-8 000 tpa. Expansion of rolling capacity is undertaken by Ebner of Austria (furnaces), and Skoda of Czech Republic (rolling mills). Modernisation of the wire bar section is undertaken by Mannesmann-Demag of Germany; it involves two rod rolling mills; the first was commissioned in 1994, the second will be commissioned in 1995. Modernisation of the magnet wire producing unit (to produce range of diameters 0.15-1.5 mm), is being done by MAG of Austria in association with German manufacturers of equipment; production will be 7 000-8 000 tpa, depending on wire diameter.

2.6 MARKETING OF PRODUCTS

2.6.1 STRUCTURE OF SALES OF COPPER

After smelting and refining, refined copper cathodes are marketed as follows since the independence of Kazakhstan and the new rights of producers to export freely their production (135 250 t in 1994):[7]

- almost all the production of cathodes, (95%), is delivered to far away countries. The main market is the European Community;
- the remaining 5% are delivered to the transformation plant. Transformed products of copper and copper alloys are traditionnally marketed in Kazakhstan and in the CIS (more than 1500 clients).

2.6.2 CLIENTS OF BALKHASHMED'S PRODUCTS

A list of clients, consumers of Balkhashmed's products, is given below.

2.6.2.1 COPPER CATHODES

1. Consumers in the European community[8]
2. Ust- Kamenogorsk, Pb-Zn plant (Kazakhstan)
3. Joint - stock company (JSC) “ VK - Tsvetmet”,Ust-Kamenogorsk
4. “Titan ”company, Omsk (Russia)
5. JSC “Azovmash“, Mariopol, (Ukraine)
6. “Uralelectromed” combinat, V- Pyshma, Sverdlovsk region (Russia)

[7] Supported by list of clients with quantities sold.

[8] Supported by list of clients with quantities sold.

7. ‘Kamkabel “combinat, Perm (Russia)
8. Joint- venture ‘EZOBEL”, Minsk (Belorussia -Lithuania)
9. « Metkab » LTD, Moscow (Russia)
10. JSC “Autodiesel” , Yaroslave (Russia)
11. Zhezhent mine-concentration complex, Zhezkent, Semipalatinsk (Kazakhstan)
12. « Tsvetmet » company, Almaty
13. East- Kazakhstan chemical-metallurgical combinat, Ust- Talovka, East-Kazastan

2.6.2.2 SULPHURIC ACID H_2SO_4 TECHNICAL.

1.JSC “Superphosphatnyi zavod “, Zhambyl

2.JSC “Kaskor “, Acktau

3.Central mining dept., Taukent, South- Kazakhstan region

4.Mining dept. No 5 , Kyzymchek

5.Mining dept. No 6 , Chiili, Kzyl-Orda region

6.Aluminium plant, Pavlodar

7.Plant of chrome compositions, Ackiubinsk

8.JSC “Phosphochim “, Alga, Acktiubinsk region

Note: All the main consumers are from Kazakhstan 1994. Some consumers, to whom are delivered small amounts of acid, are not mentioned (Kazakhstan and Kyrgyzstan).

2.6.2.3 SLIMES OF THE ELECTROLYTIC REFINERY, CONTAINING PRECIOUS METALS.

1. Pb-Zn combinate, Ust - Kamenogorsk

2. Pb plant Chimkent

2.6.2.4 COPPER SULPHATE

1.Pb combinate, Zyrianovsk, East-Kazakhstan region

2.Pb-Zn combinate, Tekely, Taldykorgan region

3.Polymetallic combinate, Leninogorsk, East-Kazakstan region

4.‘Kazwolfram ‘ combinate, Ackchatau, Zhezkazgan region

5.Mine-concentration combinate, Kargaily, Karaganda reg.

2.6.2.5 TRANSFORMED PRODUCTS

More than 1500 clients in ex-USSR.

2.6.3 TRANSPORT OF COMMERCIAL PRODUCTS

Transportation, as a rule, is realized by rail, in covered vans and tanks, depending on the type of product. Slimes after treatment (concentration, leaching drying and milling) are transported by the consumers themselves (in plastic bags of 20kg by truck), as an exception self-delivery of copper and of $CuSO_4$ is also possible.

Overall transport is the responsibility of the transport department, and, partially of the department of international affairs (delivery of copper to far abroad countries through sea ports)

2.7 HUMAN RESOURCES

Manpower of the whole combinate is approx. 14 000 (including the Kounrad and Sayak mines) in january 1995 [9]. The distribution of personnel is as follows, with indication of main units, industrial and non industrial, workers and staff.

[9] List of personnel employed is available in the data room, for the past 5 years, with indication of industrial and non industrial.

Balkhashmed: distribution of personnel as of 1/1/1995

	workers	staff	total
direction & administration	47	421	468
mines	1 966	253	2 219
concentration plant	682	70	752
mines & concentrating plant	2 648	323	2 971
smelting & refining	2 180	180	2 360
incl. concentrate preparation	*410*	*34*	*444*
incl. smelting	*849*	*65*	*914*
incl. electrolytic efining	*487*	*33*	*520*
incl. acid plant	*261*	*30*	*291*
incl. maintenance	*115*	*10*	*125*
incl. Cu sulfate plant	*58*	*8*	*66*
copper alloys transformation plant	937	171	1 108
spare parts fabrication plant	645	84	729
total industrial personnel	6 457	1 179	7 636
total non industrial personnel	4 920	1 097	6 017
of which social proper (*)	2 138	734	2 872
auxiliary workshops	*17*		17
construction & erection unit (*)	*507*	*56*	563
supplies unit	*116*	*18*	134
maintenance of housings (*)	*780*	*106*	886
kindergardens (*)	*450*	*518*	968
recreational (*)	*47*	*1*	48
medical (*)	*50*	*12*	62
truck unit	*213*	*13*	226
railway unit	*363*	*48*	411
repair & erection unit	*793*	*90*	883
scientific research center	*133*	*52*	185
central computer laboratory	*71*	*34*	105
repair & erection unit	*250*	*20*	270
electric power line unit	*70*	*12*	82
heating unit	*98*	*3*	101
electric repair unit	*243*	*21*	264
communication services	*24*	*2*	26
technical control department	*121*	*13*	134
gas & rescue unit	*14*	*2*	16
machine calculation station	*28*	*8*	36
agricultural farms (*)	*304*	*41*	345
guards & security	*228*	*27*	255
total complex including (*) social proper	11 377	2 276	13 653
total complex excluding (*) social proper	9 239	1 542	10 781
production t Cu cathodes			135 247
production t Cu equivalent (incl. add-on Au & Ag)			180 512
productivity based on total personnel of the complex t Cu ec year excl. social			16.7
productivity metallurgy alone t Cu equivalent/man year excl. social			76.5
compares to an international reference of 60 t Cu/man year.			

Non industrial units cover all the requirements of logistics, utilities, manufacture of spare parts, maintenance and social infrastructures for the employees. This situation is imposed by the remote location of the combinate and the structure of industrial enterprises in ex-USSR.

Social infrastructures are managed by a special Division of the combinate. Its total costs are covered, on the one hand by payments made by its beneficiaries i.e. the personnel, and on the second hand by a subsidy from the combinate. The subsidy is by far the major source of financing of the total social costs (>80%). If several or all of the social infrastructures were segmented in the future, (e.g kindergartens, schools, recreational and cultural centers, medical assistance, farms and company shops, etc.), as economic, political and social reforms gather momentum, the costs would not disappear but they would have to be financed differently, for example more of them would be paid by the beneficiaries (kindergartens, recreational), some by the town and region (cultural, schools), some by the state (schools, medical). The value added required to cover all these costs still has to be created by copper production, but it will be distributed directly to the personnel in the form of increased wages.

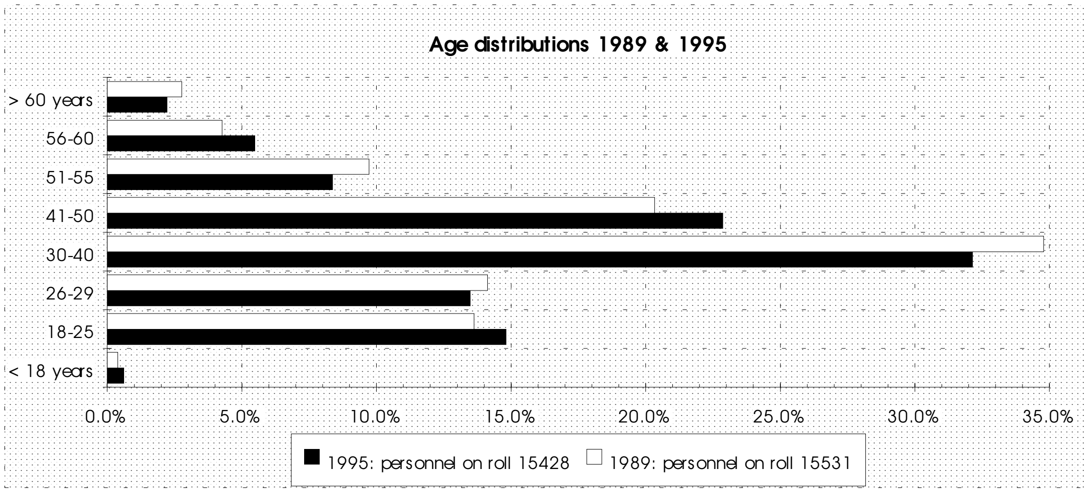
As a result of social infrastructures, the productivity of personnel is apparently low, as shown in the previous table. However, the average personnel cost per capita is also very low, i.e. in proportion with GDP/capita in the country, as shown in the table below.

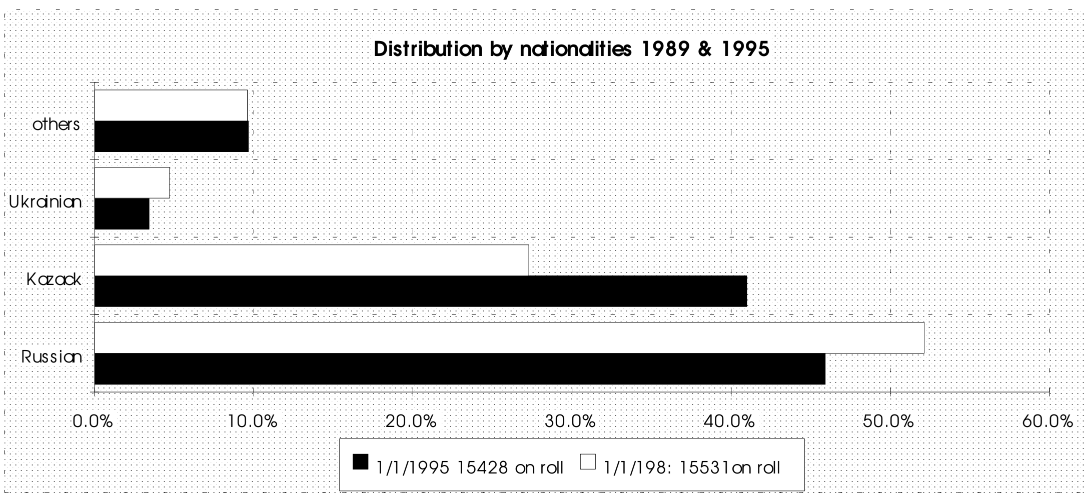
	Balkhashmed		**Western Europe**
	Te	US$	US$
average cost of personnel /month	4 275	125	2 000
average cost of personnel /year	51300	1 502	24 000

Personnel productivity, based on a total of 13 788 employees, with 9 621 in metallurgical operations industrial and non industrial (i.e. excluding mines and concentration plant), and a production of 135 247t of refined Cu as in 1994, means an overall productivity of 10 t Cu/man year and a productivity for industrial personnel in metallurgical operations only of 37.5 t Cu/man year. The international reference for the latter figure is 60 t Cu/man year. By adding to the production, the by-product precious metals expressed as equivalent Cu, a level of 180 000 tpa equivalent Cu is obtained and the productivity of personnel would be as follows:

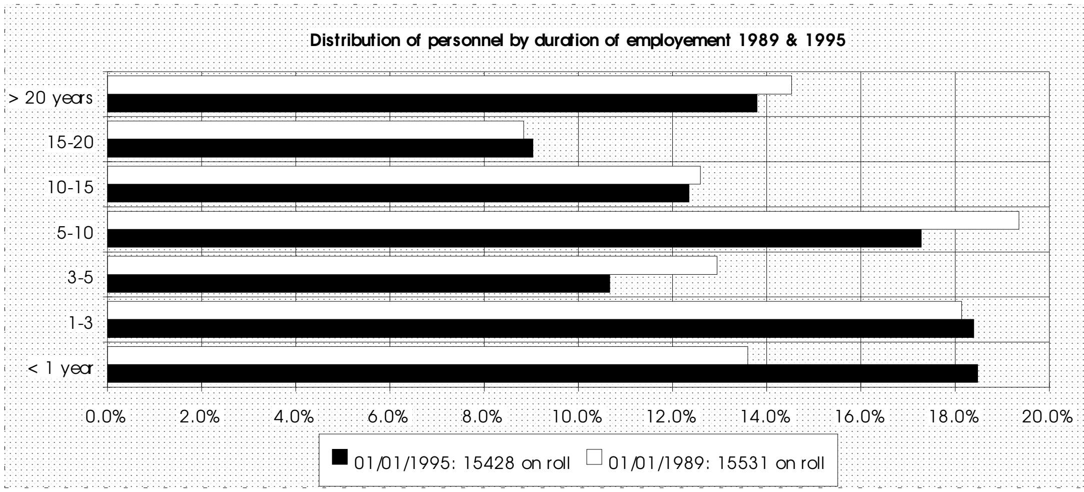
production t Cu equivalent (incl. add-on Au & Ag)	180 000
productivity based on total personnel of the complex t Cu equiv /man year excl. soci	16.7
productivity metallurgy alone t Cu equivalent/man year excl. social	76.3

The basic structure of personnel of the combinate is shown in the following tables for years 1989 (last normal year before disintegration of the USSR) and 1995[10]:





[10] *Total personnel shown is personnel on roll, which differs from personnel actually employed, as shown above.*



2.8 INFRASTRUCTURES

Balkhashmed copper combinate is located in south eastern part of Kazakhstan, in the middle of the northern shore of lake Balkhash; the town and its immediate area (Kounrad mine) is almost entirely dedicated to the mining, concentration, smelting and refinining of copper ores. The combinate provides its personnel with the full spectrum of social services: housing, kindergartens, schools, full medical care, recreational and cultural centers, farms and company shops, etc.[11]

Apart from Balkhashmed, there is a very large building and construction company in Balkhash which works for the community, building roads, undertaking civil works, houses and communal buildings. The company undertakes contract work for Balkhashmed.

Turan Bank has a branch in the city.

Three commercial jet flights connect Balkhash to Almaty; the flight takes 50 minutes. In addition, the company operates a private turbo-jet aircraft which commutes with Almaty and other cities in Kazakhstan, for the benefit of management on official duty and for the personnel of the combinate.

Balkhash is connected by an all weather macadam road to Karaganda (260km N), and Almaty (600km around the west side of the lake).

[11]Supported by data in the data room:list of all non industrial buildings and facilities, personnel employed, costs of operation, etc.

Balkhash is connected by rail to the major industrial regions and cities of Kazakhstan: Karaganda to the north (260km), Semipalatinsk, Ust Kamenogorsk (800-900 km) and Dostik (800km) to the North and East (rail junction near Actogay[12] at 375km to the East of Balkhash), Chimkent (900km) and Almaty (750km) to the south (rail junctions at Moynty and Chu).

The combinate is connected to the national power grid through a high voltage transmission line originating from Karaganda coal mining region. There is also a power generating plant on adjacent to the site of the complex (four units of 60 MW, of which two operating today).[13]

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[12] Actogay is the name and location of a major copper orebody in Kazakhstan, and of another one nearby called Aidarlay. Each of these orebodies contain about 5 Mt Cu. They are covered by a fairly extensive zone of oxydised copper sulphides.

13Supported by data in the data room: transport distances and conditions; costs; power grid characteristics...

3. PLANT AND EQUIPMENT OF THE SMELTER REFINERY

A simplified flow-sheet of the copper combinate is shown overleaf.

In general, the state of plant and equipment and the performance of the main process units is satisfactory as attested by the main operating parameters of the plant. Obviously there are investments to be made for technology improvements as well as for maintenance of plant and equipment which has suffered some deterioration during the recent years of economic drastic changes. Balkhashmed has a plan to upgrade technology, improve production of copper and thereby to increase the productivity of all factors, overall. These plans are dealt with in a later section.

Details on plant and equipment, supplementing the flow-sheet, are given hereafter.

3.1 CONCENTRATE PREPARATION SECTION

This unit obtains raw materials from more than ten sources: local (concentrate from Kounrad and Sayak ores, Balkhash concentrates), outside and imported concentrates and clinker (3 origins).

Imported materials are transported to the complex by railroad, Balkhash concentrate are delivered as pulp from the flotation plant which is adjacent to the metallurgical complex.

Except pulp containing Cu, there is also pulp of magnetite concentrate coming from the flotation plant. After vacuum disk filtering, it is conveyed to a special storage area outside the preparation section.

The concentrate preparation plant consists of three sections:

1. first section for crushing of the charge (one cone crusher (large sizes), two cone crushers (medium sizes); this is for outside concentrates which may have agglomerated during transport (e.g. Mongolian which arrive frozen in winter (2-15% moisture content).
2. stacking and bunkering of the disaggregated charge;
3. a drying and filtering section: it consists of seven vacuum disk filters, and seven rotary dryers for the Cu and magnetite lines.
4. There are 2 stages of drying of the concentrates which are delivered in pulp form by the flotation plant or repulped (e.g. Mongolian concentrates in winter)
    - vacuum filters to 15 % H_2O
    - rotary furnace dryers to 4 - 5 % H_2O

All the transportation is by belt conveyors.

NB: 1: Today filter disks are being replaced by ceramic filters.

2. Production of magnetit concentrate is temporarily stopped.

- This section is also in charge of the handling and storage of all copper raw materials (copper scrap, blister copper, copper mattes, copper waste and rejects etc.), as well as fluxes (auriferous ores and concentrates which provide silica and iron oxides necessary for the smelting processes, limestone, etc.). The stockpiling and reclaiming area is outside and far from the preparation uni. The raw materials are brought ahead of the preparation unit where they are pre-mixed in set proportions in order to achieve as uniform grade as possible.

- The reverbatory furnaces are fed by the pre-mixed materials (a surge stockpile exists between).
- The Vanjukov smelters require a better homogeneized charge; so there are three blending halls (of 12 000t each) ahead of the Vanjukov furnaces. The Vanukov smelter charge is prepared in homogeneized stocks with stacking and reclaiming facilities (of the type Hewitt Robin). Concentrates are stacked in layers of 300-500t of each origin. The tonnage of stockpiles made of 8-10 different layers is about 12 000 t. There are three homogeneization stockpiles, housed in a covered building. One stockpile is being constituted (the stacker stacking materials longitudinally), while another is being reclaimed (the reclaimer operates transversally). The reclaimed stockpile sends its products to the bunkers of the Vanukov furnaces.

3.1.1 DISTRIBUTION OF COPPER SUPPLIES

In 1994, more than ten sorts of concentrate were handled in this section. The distribution of these sources is the following:

concentrates from Balkhashmed own mines and flotation plant (Kounrad and Sayak)	22.4%
Kazak concentrates	20.3%
Mongolian concentrates	32.0%
Chilian concentrates	7.6%
Kazak blister copper	15.7%
total	100.0%

3.2 FLUXES AND ADDITIONS

Important quantities of fluxes are required to separate copper and other metals of the charge from gangue materials in the smelting processes (slag production in the Vanjukov, the reverbatory furnaces and the converters). Most of the fluxing materials are provided in the form of auriferous ores or concentrates, which are quartzites. These auriferous materials contain gold, silver and other precious metals which accompany the copper in the smelting processes and are finally separated in the electrolytic cell slimes[14]. The auriferous materials (quartzites) provide

[14] Supported by appropriate data in the data room: Au/Ag and other precious metals content of the concentrate feed; values obtained in electrolytic slimes; provide analyses of slimes, and quantities produced.

the silica and the iron oxides which are required for the metal/gangue separation and for the production of slags. The other fluxes in the smelter charge are limestone.

Coal dust is mixed with the charge. The coal must be of maximum volatile content to avoid explosions in the furnace; anthracite is the preferred fuel because of high calorific value, low ash and low volatile matters.

Prior to the disintegration of the USSR, this most suitable type of coal came from the Kouzbass region, North-East of Ust Kamenogorsk.

- calorific value kcal/kg 6 000
- ash % 10-15
- volatile matter 30-35

Today sub-bituminous coal is supplied by Karaganda region, but it is lower calorific value (5 200 kcal/kg), high ash (18-26%) and higher in volatile matters (40-45%), its quality is therefore less favourable.

	1991	1992	1993	1994
total feed (a) dry tonnes	705 751	749 031	763 757	799 590
of which auriferous quartzites	141 858	124 156	94 452	138 268
of which other fluxes	2 360	17 672	54 300	69 268
total fluxes (b)	144 218	141 828	148 752	207 536
b/a %	20.43%	18.93%	19.48%	25.96%

3.3 COAL PREPARATION SECTION

The coal preparation section receives coal from Karaganda mines. Coal must respond to certain specifications as required by the smelting processes. Volatile matter must be below 35% to avoid explosion risk in the smelters.

Coal is prepared (crushed, screened, and dried) prior to supply to the smelters.

3.4 SMELTERS

There are two processes of smelting: two Vanjukov smelters of Russian technology and two conventional reverbatory furnaces.

At present, only one Vanjukov furnace is operating. The other one is out of service due to the lack of a major spare part (gas recovering system to be procured in Russia). It needs to be rehabilitated and relined with refractories.

3.4.1 VANJUKOV FURNACES

The Vanukov process was created for smelting of wet sulfide Cu concentrates. The product is matte (Shtein in Russian). It is rich in Cu content (up to 50 % Cu), slag Cu content is low, and SO2 grade of gases is rich and the latter can be used for H2SO4 production. It is a continuous process, smelt in bath, with metal gangue separation in liquid phases of different densities.

- t° of the bath 1300°C
- t° of gases at outlet 1100-1200°C
- Calorific value of charge approximately 480 kcal/kg
- Autogenous smelting in liquid bath, with burning of sulfides in the slag and reduced heat requirement (due to blowing of air, enriched with oxygen).
- Vertical movement of smelted materials from top to bottom.

Vanukov furnace has two functional zones.

1. Smelting, oxidation of sulphides and enlargement of sulfide particles takes place in the upper zone (blowed with oxygen).
2. Washing out of slag by drops of matte (shtein) and separation of shtein and slag takes place in the lower zone.

Slag is transported to electric mixer for impoverishment.

Initially at Balkhasmed, there were four reverbatory smelters. This was at the time when the combinate was supplied with high grade concentrates from Jhezkazgan mine, and the average copper grade of the charge was >20% Cu. After the start of Jhezkazgan copper combinate, this source was not available any more, and the grade of the charge to the smelters declined drastically. It is for this reason that the Vanjukov technology was introduced, and ultimately two reverbatory furnaces were replaced by two Vanjukovs.

Operations are self-sufficient in energy and the gases, generated at high temperature and rich in SO2 (15-25%), are most suitable for sulphuric acid production. The gases are therefore normally sent direct to the acid plant. Productivity per square meter of furnace and 24 hours operation is forty times higher than in a conventional reverbatory smelter. The design capacity of this Vanjukov furnace is 50 t/h of charge. There are two zones of reaction: from top to bottom, a smelting zone where oxidation of sulphides and enlargement of sulphide particles occur in the upper beds (enriched with oxygen blowing), washing out of slag by droplets of matte and the separation of matte and slag take place in the lower beds. The matte produced contains up to 50% Cu. Bath temperature is 1300°C; temperature of gases at the outlet 1100-1200°C and calorific value of the charge is approx. 480 kcal/kg.

At 70% overall efficiency rate, this furnace can process 306 600t of charge/year; and with the quality of concentrates available today (14-16% Cu in the charge), and a rate of Cu recovery of 96.6%, this corresponds to a production of 40 000-47 000 t Cu content in matte.

The main operating parameters of the Vanjukov smelter in the period from 1991 to 1994 are shown below:

Vanjukov data operating data:

	1991	1992	1993	1994
total feed t Cu content (a)	30 962	51 209	40 700	38 959
% Cu	11.6%	14.1%	15.0%	12.3%
matte produced t Cu (b)	28 544	46 163	37 434	35 820
% Cu	43.5%	43.9%	44.9%	42.9%
slags t Cu	1 740	360	1 580	773
% Cu	1.26%	1.72%	0.83%	1.20%
Cu entrained in gases t Cu	203	106	390	131
balance t Cu	475	4 580	1 296	2 235
losses	678	4 686	1 686	2 366
yield %	97.8%	90.8%	95.9%	93.9%
yield mattes % b/a	92.2%	90.1%	92.0%	91.9%
hours operation	5 609	6 849	6 080	5 686
t Cu/hour operation	5.09	6.74	6.16	6.30
overall efficiency (% hours/total year)	85.9%	104.9%	93.1%	87.1%

3.4.2 Reverbatory Smelters (2 furnaces)

Because of the stoppage of one of the two Vanjukov smelters, the two reverbatory smelters supply approx. 70 % of copper in matte. The two identical furnaces are of conventional design:

Surface m2	225
Design productivity t charge/m2 and 24 hours	3.64
Temperature at the head	1450-1580°C,
Temperature at the end	1220-1320°C,

Fuel is coal dust prepared specially in the coal preparation plant.

By design, the productivity per square meter of furnace and 24 hours of operation is 3.64 t of charge. At 77% overall efficiency rate (accounting for campaign stops of 35 days, plus 17 days of scheduled stops, and 90% availability), the reverbatory furnaces can process 230 720 t of charge/year; and with the Cu content of the charge as of today (16-18% Cu in the charge, because higher grades are necessary than in the Vanjukovs), a rate of Cu recovery of 98.4%, this corresponds to a production of 35 000-40 000 t Cu content in matte. Copper matte produced is 28-30 % Cu, 28-40% Fe and 25-26% S.

The main operating parameters of the reverbatory furnaces in the period from 1991 to 1994 are shown below:

Reverbatory smelter operating Data

	1991	1992	1993	1994
total feed material t Cu (a)	70 023	68 912	90 261	91 871
% Cu	10.0%	10.9%	11.7%	11.7%
matte produced t Cu (b)	66 567	64 860	86 466	88 137
% Cu	26.4%	30.8%	29.2%	30.0%
slag t Cu	2 256	2 053	2 695	3 188
% Cu	0.63%	0.77%	0.63%	0.65%
ash t Cu	286	373	198	90
% Cu	8.38%	5.40%	5.70%	6.00%
Cu entrained in gases t Cu	1 214	770	664	456
balance t Cu	-300	856	238	
losses	914	1 626	902	456
yield %	98.7%	97.6%	99.0%	99.5%
balance % of total feed	-0.4%	1.2%	0.3%	
fresh feed t Cu	64 786	64 789	85 799	87 263
% Cu	14.20%	15.00%	15.80%	16.30%
recycled feed t Cu	4 937	4 125	4 462	4 709
% Cu	2.04%	2.90%	1.90%	1.90%
yield mattes % b/a	95.1%	94.1%	95.8%	95.9%
hours operation	13 848	12 424	14 071	15 415
t Cu/hour operation	4.81	5.22	6.14	5.72
% utilisation	39.5%	35.5%	40.2%	44.0%
t feed/m2* hour	4.81	5.22	6.14	5.72

3.5 CONVERTERS

The converters transform matte (sthein) into blister copper by blowing of compressed air enriched with oxygen. There are five horizontal converters each equipped with an individual gas removal system.

Other than matte, the following materials are used in the process of conversion: fluxes and granulated Cu concentrate,

Air consumption is 30 000 Nm3/hour

SO2 content of the gases is 5.5 %

The five horizontal converters operate according to normal and classical procedures with individual combustion gas removal system. They are fed by the two Vanjukov and the two reverbatory matte furnaces with additions: fluxes, granulated Cu recycled from the electrolytic cells, external copper mattes and other recyclings e.g.anodes, rejected cathodes and copper scrap. Oxygen enrichment blowing is also available.

Cycle time is 12 hours and the charge per cycle is 218 t. The average Cu % of the matte charged to the converters was 35.7% in 1994. With three converters permanently in operation, two in maintenance, the overall average scheduled efficiency is 60%; so with the Cu% of the matte, which results itself from the quality of concentrates available today, the maximum capacity of the converters is of the order of 170 000 t/annum of blister copper.

3.6 COPPER BALANCE FROM CONCENTRATE PREPARATION TO BLISTER STAGE

The following table shows the balance of copper from concentrate preparation to blister stage:

	1991	1992	1993	1994
concentrates Balkhashmed t Cu	36 398	30 622	31 460	29 519
% Cu	14.8%	14.0%	14.1%	14.7%
external concentrates t Cu	52 519	75 581	85 772	85 772
% Cu	17.5%	19.6%	23.4%	23.9%
total concentrates t Cu	88 917	106 203	117 232	115 291
% Cu	16.3%	17.6%	19.9%	20.6%
other supplies t Cu (scrap, slags, waste etc.)	1 739	947	1 497	5 036
% Cu	19.60%		50.20%	28.00%
total copper supply t Cu	90 656	107 150	118 729	120 327
% Cu	16.34%	17.73%	20.03%	20.83%
Vanjukov	30 962	51 209	40 700	38 959
reverbatories	70 023	68 912	90 261	91 871
total	100 985	120 121	130 961	130 830
total losses t Cu of which	6 021	9 969	4 364	6 789
Vanukov slags	1 740	360	1 580	773
Cu entrained in Vanukov gases	203	106	390	131
balance Cu Vanukovs	475	4 580	1 296	2 235
reverbatory slags	2 256	2 053	2 695	3 188
ash reverbatories	286	373	198	90
Cu entrained in gases reverbatories	1 214	770	664	456
balance Cu reverbatories	-300	856	238	
balance blister	147	871	-2 697	-84
blister copper produced	84 823	99 506	113 690	113 690
% Cu	98.75%	98.72%	98.80%	98.82%
overall rate of recovery %	93.57%	92.87%	95.76%	94.48%

3.7 ANODE FURNACES AND ANODE CASTING MACHINES

In this unit, the following operations are conducted:

- Flame refining of liquid blister Cu and solid imported blister Cu,
- Casting of anodes for the electrolytic refinery.

There are 3 anode furnaces of 200-250 t/day capacity each.

- Fuel heavy fuel oil.
- temp of liquid blister Cu 1150-1200°C
- temp in furnace 1350°C

Regeneration of Cu by steam-mazut emulsion in smelted bath through tubes.

- Mazout pressure 5-6 atm.
- Air pressure 4-5 atm.

Cu from the anode furnaces flows to carousel casting machines. Cu anodes are then prepared, selected and transported to the electrolytic refinery.

Furnace cycle time is 18h. A campaign lasts 18 months, at the end of which there is a major stop of 20 days for maintenance, and there are 20 days scheduled stops during operation. With an availability of 97.5%, this gives an overall efficiency rate of 90.4%; and with a charge of 200 t/day, at 98.8 % Cu, the capacity is 87 000 t/annum, i.e. 261 000 t Cu for 3 furnaces.

The main operating parameters of the anode furnaces in the period from 1991 to 1994 are shown below:

Anode furnaces operating data

	1991	1992	1993	1994
Balkhashmed blister t Cu	84 921	99 506	113 022	113 658
external blister (Irtych) t Cu	37 162	27 013	23 490	19 535
recycled anodes t Cu (a)	32 236	28 581	33 102	27 792
rejected anodes (quality control) t Cu (b)	2 972	2 911	2 654	2 348
other sources t Cu	1 133	8 455	4 521	2 137
total copper supply (c)	158 424	166 466	176 789	165 470
production of good anodes (d)	153 478	161 686	171 065	159 908
anode recycling a/d %	21.00%	17.68%	19.35%	17.38%
defective anodes b/c %	1.88%	1.75%	1.50%	1.42%
rate of recovery %	96.9%	97.1%	96.8%	96.6%
Balkhashmed blister % of total supply	53.6%	59.8%	63.9%	68.7%

Cu flows from anode furnaces to carrousel casting machines (three machines in good condition), from where the anodes are transported to the electrolytic refinery by a continuous transport system.

Anode aspect is quite correct, they are flat and smooth. After quality control, approx. 1.5% of the production is refused and recycled. For 300 000 t of refined copper per year, the requirement of anodes is 380 000. In 1994, the utilisation rate of the three furnaces was 80 %, for a reported production of 132 000 tons of anodes (9 months).

3.8 ELECTRO-REFINING

The capacity of this plant is 300 000 t Cu per year. The starting sheets section is in good condition, the sheets are smooth and straight. The utilisation rate of the sheets produced is excellent, 95 %. Anode cycle is 21 days and cathode cycle 7 days. Current density is 213 A/m3 compared to a design value of 220 A/m3. Current efficiency is 92 % for a nominal value of 94 %.

Electrolyte composition is:

Cu 40-45 g/l,

Ni 20-30 gr/1,

As 10-20 gr/1,

Sb 1-1.2 gr/1,

H2S04 100-200 gr/1.

3.9 PROCESS CONTROL

All the furnaces used for matte and blister production are controlled from a central control room. All devices controlling the physical parameters (temperature, material flows, gas flows, oxygen and pressure) are installed. The dispatcher follows the process on video screens, which indicate, in real time and on flow sheets, the state and evolution of all operating parameters of the process. The results of chemical analyses of the different outputs (matte, blister, slags), are communicated by phone every hour to the control room, by the central laboratory.

3.10 LOGISTICS AND UTILITIES

3.10.1 RAIL ROAD UNIT

The rail road unit of the complex provides transportation of all raw materials, inputs semi-finished and finished products within the metallurgical combinate. There are 17 diesel locomotives, 5 electric locomotives, 3 rail mounted cranes, 430 six wheel wagons, 113 eight wheel wagons, 86 dumpers, 225 railway points in the complex.

3.10.2 POWER PLANT

A coal fired power plant, adjacent to the plant (two units of 120 MW) provides power to the complex and to Balkhash town, in addition to electric power from the national grid which is supplied to the area from Karaganda region, through a high tension line and main transformer station at the entry of the town. The plant has been severed from Balkhashmed and is operated independently, with coal from Karaganda region.

4. ENVIRONMENTAL ASPECTS

4.1 THE REGULATORY ENVIRONMENT

Since the disintegration of the USSR, and under pressure from international institutions including the IMF and the World Bank, and also the EC, the government of Kazakstan has enacted stringent regulations for the release of noxious gases to the atmosphere.

As of beginning of 1995, Government taxes noxious gas releases to the atmosphere on a flat rate of 0.8 Te/tonne (50 Te/US$ as of Jan 1995), according to a scale of harmfulness, and up to a maximum level:

SCALE OF HARMFULNESS	
SO2	20
CO2	0.3
Nox	25
CS2	200
H2S	125

Considering for example SO2 only, which is the major polluter by weight, the penalty for gases is calculated as follows, up to 300 000t/annum:

P=Rx20x0.8 (where P is penalty and R tonnes released)

Above 300 000t/annum, the flat rate is multiplied by 10, i.e. the penalty is 8 Te/t.

P=Rx20x8 (where P is penalty and R tonnes released).

The regulations are presently permissive, up to 300 000 tpa of SO2 release.

4.2 MAIN ENVIRONMENTAL MEASURES ACHIEVED AT BALKHASMED IN PERIOD 1989-94 AND PLANNED

Every year the environmental department and the department of industrial ventilation and gas treatment, work out "plan of the main environmental measures" taking into account suggestions of plants and units.

This plan is coordinated with Balkhash town department on ecology and bio-resources. Usually, the plan includes 40-50 measures which are divided into organizational measures and measures connected with the conservation of the atmosphere, water, soil and underground resources. In addition, other plans are worked out as well as a program of environmental inspections (operating plan) for the main process units of the combinate and in the event of unfavorable meteorological conditions, etc.

In 1989-94, the following measures were implemented:

- acid plant N°2 for the utilization of SO2 gases from Vanjukov furnace N°2 was built and its exploitation was started. Capacity is 180 000 t/year H2S04;
- collective gas line for the waste-tailings of the acid plant N°1 was built. Its exploitation improved the ecological situation in the industrial areas and in the town of Balkhash;
- secondary gas removing pumps were installed for the reverbatory and the Vanjukov furnaces;
- every year the effectiveness of all the gas cleaning equipment is tested. A program and schedule of maintenance and revamping is worked out based on those tests;
- preparation for exploitation of industrial water pump station N°2 is being implemented. With the start of its exploitation, the combinate will save 12 million m^3 of water. Waste water-less system will then be used.

It is also worth mentioning that Balkhashmed undertakes to attract foreign technology and investments in field of environment and ecology:

- the combinate is the first enterprise in Kazakhstan, to acquire and apply environmental monitoring technology supplied by the reputed Swiss company "ATS";
- the precious metals refinery constructed by the Swedish company « Boliden Contech » is accepted as « ecologically clean » by the international community;
- vacuum disk dryers of the concentrate preparation section will be changed by ceramic filters Ceramec from Finland. Wastes of harmful substances from that section will then be stopped;
- A program for decreasing SO_2 emissions was worked out for the period 1994-2007. It includes the construction of acid production plant N°3 (capacity 110 000 tpa and start of exploitation 1998) and the utilization of sulfuric acid up to 58.9%.
- there is an agreement with "ATS" company for the registration of a joint venture company for the construction of an ammonium sulphate fertilizer production plant;
- it is considered to increase the utilization of sulphuric acid by 12-15% thanks to production of commercial ammonium sulphate, as well as by installation of gas cleaning equipment and equipment for the production of gypsum from excess sulphuric acid with lime.

4.3 BALKHASMED SULPHURIC ACID SITUATION

4.3.1 ACID PRODUCTION

In 1994, Balkhashmed produced 88 456 t of acid in its operating acid plant N°2. The latter plant can produce up to 180 000 tpa. Acid production is constrained by limited market outlets.

For a production of blister copper of 120 000t, 276 000 t SO2 were released to the atmosphere, calling for a penalty of 4.4 M Te (0.09 MUS$, or 0.33 mills US$/lb blister for SO2 only). This suggests that the maximum permitted SO2 release at minimum penalty is almost attained. Hence the need to construct new acid facilities.

Historic production of acid and release of SO2 gases at Balkhashmed is shown in the following table:

	1 973	1 989	1 990	1 991	1 992	1 993	1 994	program
Refined copper (t)	308 165	240 788	163 372	120 023	126 623	138 045	135 247	180 000
own blister copper	220 000	172 000	116 700	84 922	99 506	113 022	120 000	140 000
total acid content of gases, tonnes	1 063 372	759 563	523 017	547 194	432 586	639 493	511 331	676 691
SO2 content	694 447	496 041	341 562	357 351	282 505	417 628	333 930	441 921
% recovery of gases	22.28%	32.94%	32.62%	7.84%	25.02%	8.48%	17.21%	57.63%
acid produced tonnes	236 953	250 200	170 608	42 900	108 233	54 229	88 000	390 000
SO2 content tonnes	154 745	163 396	111 417	28 016	70 683	35 415	57 469	254 694
SO2 released to atmosphere tonnes	539 702	332 645	230 144	329 335	211 822	382 213	276 461	187 227
t acid required for 80% recovery of gases	850 698	607 650	418 413	437 755	346 069	511 594	409 064	541 353
t SO2 released to atmosphere	138 889	99 208	68 312	71 470	56 501	83 526	66 786	88 384
t acid required for 90% recovery of gases	957 035	683 607	470 715	492 474	389 327	575 544	460 198	609 022
t SO2 released to atmosphere	69 445	49 604	34 156	35 735	28 251	41 763	33 393	44 192
t acid produced/t blister	4.83	4.42	4.48	6.44	4.35	5.66	4.26	4.83
t S produced/t blister	1.58	1.44	1.46	2.10	1.42	1.85	1.39	1.58
average S/Cu ratio	1.58	1.44	1.46	2.10	1.42	1.85	1.39	1.58
1973: calculated on average of subs years								
penalty M Te	43.2	10.0	3.7	9.5	3.4	18.0	4.4	3.0
Te/$	50.0							
penalty M S$	0.863	0.200	0.074	0.190	0.068	0.359	0.088	0.060
mills $/lb blister	1.780	0.529	0.286	1.014	0.309	1.442	0.334	0.194

4.3.2 ACID PLANT INVESTMENTS IN PROGRESS

The present capacity of acid production in acid plant N°2 is 180 000 t in two units.Acid plant N°1 is old and out of service. A project is currently being implemented to a build acid plant N°3 for 110 000 t of acid in two units at a capital cost of 20 MUS$. Total capacity of acid production will therefore be 390 000 t after completion of this project.

Considering an average S/Cu ratio of the charge to the smelters of 1.4-1.8 as from 1989 to 1994 (see table above), this means that for a production of 180 000 t cathodes, with 140 000 t of blister copper required from Balkhash smelters, the combinate would burn approx. 224 000 t sulphur, which corresponds to 448 000 t SO2 and 686 000 t of sulphuric acid[15].

Assuming 390 000 t of acid are produced, there would be 296 000 t or 193 000 t of SO2 gas released to the atmosphere with a penalty of 3.0 M Te (for SO2 only). The rate of treatment of sulphur is 390 000/686 000=56.7%. If one considers a higher rate of treatment of 80%, from the point of view of the environment, 540 000 t of acid should be produced, and only 88 000 t SO2 would be released, with a penalty of 1.4 M Te. This would call for an additional acid plant capable of producing 150 000 t more acid[16].

4.4 OTHER ENVIRONMENTAL ASPECTS

Apart from gaseous emissions from the smelters, the other main environmental issues are in the concentration plant (tailings dump) and the mines. The tailings dump is located along lake Balkhash, separated by sealed embankments and all the water is recycled to the concentrator. The problems of mines are mainly waste extraction and disposal on the dumps and associated dust emissions.

4.5 ENVIRONMENTAL LIABILITIES

Environmental liabilities related to past operations are apparently nil. However, if any such liability occurred, it would be borne entirely by the Government

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[15] *atomic weights: S 32, SO2 64, H2SO4 98.*

[16] *Balkhashmed's production program is for 120 000 t of blister only. the complex would burn approx. This represents 230 000 t sulphur, which corresponds to 460 000 t SO2 and 690 000 t of sulphuric acid. Assuming acid production of 390 000 t, there would remain 300 000 t acid equivalent released to the atmosphere, i.e. 200 000 t SO2. And the rate of treatment would be 390 000 t/690 000 t=56.5%.*

5. TECHNOLOGICAL IMPROVEMENTS CONSIDERED FOR SMELTERS AND REFINERY

5.1 CONCENTRATION PLANT

5.2 CONCENTRATE PREPARATION AND DRYING.

The filtration and drying plant and equipments are currently being modernised and upgraded. Balkhashmed is currently replacing the vacuum disk filters by ceramic filters (from Finland). The filters are already on site, ready to be installed and put into service. The belt conveyors, the storage area equipement (reclaimers) and the building need some overhauling.

5.3 SMELTERS, CONVERTERS AND ANODE FURNACES

Except for leaks of gases, the state of all the furnaces is quite good and the dispatching and control room is well maintained. A major problem is in the gas recovery system of the smelting and converting section. Balkhashmed plans to replace the heat exchanger of the Vanjukov furnace at a capital expense of 26 US$ million.

5.4 ELECTRO-REFINING.

The maintenance schedule is to replace 15% of the cells each year. There seems to be a maintenance backlog of three years, for the cells. The silicon converters are well maintained and the maintenance backlog for the building is also about three years. A mechanised line for preparation and packaging of cathodes is considered. Bleeders could be added to some of the cells to produce some MOOK cathode quality.

5.5 ACID PLANT

This is the area of main concern for the immediate future. Balkhashmed has a plan to improve on the production and utilisation of sulphuric acid.

5.6 DUMP LEACHING OF LOW GRADE AND OXIDE ORES

Balkhashmed and a private american company, Earth Resources (ER), have set up a joint venture to recover and valuate copper from the Kounrad low grade and oxide ores. The ownership distribution of this JV is 60% Balkhasmed and 40% ER. ER is to provide technology, engineering skills and also capital funds for the acquisition of plant and equipment. Balkhasmed is to provide funds. The copper reserve in low grade ores is reportedly

112 300 t Cu at a grade below 0.5 % Cu. It is intended to use the leach in dump process, with solvent extraction and electrowinning (SX/EW). The main design data are the following, as obtained from pilot testing [17]:

Rate of recovery 63%

Yearly production 5 000 t of electrowon copper

Capacity 10 000 tons (due to the fact that the plant will operate only six months in the summer season).

Acid consumption 5 tons per ton of refined copper produced.

Dump capacity 2 000 000 t of ore.

Four dumps will be used after the starting time.

Alternatively, Balkhashmed has treated in the past, this low grade ore with a dump-leach process, followed by copper cementation. Copper cement could be smelted into 94.5% Cu in a low cost shaft furnace, and fed to the anode furnaces of the plant, thereby contributing to the copper supply.

5.7 COPPER TRANSFORMATION PLANT

This plant was built during the second world war with Russian equipment. The equipments are used to produce pure copper, monel, brass and bronze products. They are able to produce a large range of transformed products in each sort of copper and copper alloys. The main products are strips, bars, wires and sheets. Production capacity is at present about 40 000 t/year. Its precise level depends on end product mix and specifications.

Balkhashmed is building a new plant with new and modern equipment. To complete this plant Balkhashmed need 30 US$ million in addition to the 100 US$ million that has already been invested. The main equipments in this new plant are:

Two Austrian furnaces

One russian furnace with casting equipment

A wire machine able to produce very thin wire

Contirod installation, Enamel coating equipement for wire.

Thanks to this modernisation, production capacity will be between 70 000 t (copper and alloys) and 100 000 t (copper only).

[17] *Supported by adequate documentation: JV agreement details, pilot testing results (leaching time, temperature, grades achieved, rates of recovery etc.).*

5.8 PRECIOUS METALS REFINING PLANT

The construction of a gold and silver refining plant to produce gold and silver bullion from electroytic slimes is currently in progress. It is due to be completed in 1995. This is with technical assistance from Boliden of Sweden.

5.9 AMMONIUM SULFATE PLANT

There is a project to build an ammonium sulfate plant, to use acid produced, based on imported ammonia. Studies are being undertaken[18].

[18] *Data is available in the data room: origin of ammonia, quantity and price, agricultural market outlets for the ammonium sulfate produced, quantity and selling price.*

6. COST OF PRODUCTION (TECHNICAL)

The costs of production as resulting from Balkhash data is given in the following table: it shows that overall, the costs achieved are not very far from reference costs known to us. In our opinion, this result is quite promising for the future and in the perspective, at medium and long term, of meeting international standards of productivity. Indeed, it leaves a lot of scope for improvement and evolution when and as the economy picks up in Russia, the CIS and Kazakhstan. All figure have been worked out using a rate of exchange of 43 KTG as of mid 1993.

Cost of Cu materials 1993	$/lb Cu	smelting & refining c 1993	$/lb Cu	G&A cost 1993	$/lb Cu
of which concentrates 20%Cu average (excluding Au,Ag)	0.600	inputs excluding copper supply	0.047	for smelting & refining	0.015
of which blister Cu 94.5%Cu average (excluding Au,Ag)	0.800	plus personnel	0.053		
of which scrap Cu 99.2%Cu average (excluding Au,Ag)	0.810	total smelting and refining cost	0.101		
reference	0.650	reference	0.08-0.12	Reference	0.015
inputs consumed (historic)					
	1989	1990	1991	1992	1993
electricity	Rb (000s)	Rb (000s)	Rb (000s)	USD (000s)	USD (000s)
fuel	21 739	23 777	37 030	4 752	8 005
other materials	5 489	5 663	12 512	1 106	1 923
total	19 978	19 592	22 159	1 768	2 221
exchange rate units/USD	47 206	49 032	71 701	7 626	12 149
total in USD (000s)			1.75	1.00	1.00
production tonnes Cu			40 972	7 626	12 149
production Cu lb millions	240 788	163 372	120 023	126 623	138 045
cost/lb Cu	530.9	360.2	264.7	279.2	304.4
fuel coal tonnes			0.155	0.027	0.040
total US$/lb Cu					0.007
total cost of inputs US$/lb Cu					0.047

7. CONCLUSIONS ON PLANT AND OF THE SMELTER REFINERY

7.1 STRONG POINTS:

- θ The overall rate of copper recovery of the combinate, after correction, is of the order of 93 %. With reference to other plants, this is fairly good and it reflects that Balkhashmed is operating correctly despite the lack of maintenance which shows in some sections of the combinate.
- θ The aspect and the quality of refined cathodes is good. Through appropriate quality control and assurance, cathode quality can be improved to meet the specifications of LME.
- θ Cost of production is not far from reference cost of 0.10 US$/lb Cu, which gives scope for improvement in the perspective of economic recovery in Kazakhstan, the CIS and Russia.
- θ In 1995 Balkhashmed will have the capacity to produce up to 100 000 t/annum of copper transformed products (or 70 000tpa of copper alloys) and thereby increase value added and profits of sales in the Kazak and CIS countries..
- θ The state of the plant is fairly good in our opinion. We believe it can be revamped without difficulty and at least cost. Core process units are in good condition and look little affected by degradation; their performance can be greatly improved by adequate technological inputs.
- θ There are ample resources of copper available in Kazakhstan, and to Balkhashmed, which are ready to be tapped for the benefit of the combinate, and with the aid of foreign technology and finance. Approx. 20 Mt of copper resources in sulphide ores can be attached to Balhkhashmed, in 13 orebodies additional of to the present mines of Kounrad and Sayak. Of these, three orebodies are major ones (see later).

7.2 WEAK POINTS

- θ At long term, the major problem of Balkhashmed will be its copper supply in concentrates, matte and blister. Today, the main suppliers of copper concentrates are external to Balkhashmed: Kazak, but more importantly Mongolian and Chilean. Concentrates delivered by the two latter are acquired for smelting and refining, on custom basis. Consequently, for such concentrates, Balkhashmed only cashes in smelting and refining charges according to international formula practice, for copper and precious metals contained. To achieve the highest value-added and profit for Balkhasmed, it is desirable to maximize the feed of the plant with own and Kazak concentrates as well as with matte and blister copper from domestic sources. Otherwise, the combinate will become increasingly confined to custom treatment of foreign concentrates with minimal value-added.

- Based on the present structure of copper supplies, it is not possible to reach the nominal capacity of production of 300 000t/annum refined copper. Therefore, new mining and ore concentration capacity needs to be developed and commissioned as early as possible, and this is where international technology and finance will be most welcome. Bozshikul mine and flotation plant are the most advanced according to Balkhashmed [19].
- Pollution problems need to be solved urgently. They have to repair and modify the gas recovery system as soon as possible. Additional sulphuric acid capacity is required and new customers for sulphuric acid have to be found. Balkhashmed have to start as soon as possible low grade ore leaching plant and ammonium sulfate fertilizer plant.
- Productivity of resources utilised is low as in all ex-USSR industrial combinates. This applies to capital employed, inputs and personnel. Personnel productivity, based on 14 000 employees, and assuming 12 000 in metallurgical operations, a normal production of 240 000t Cu, this means a production of 20t/man year, whereas the international reference is 60 t Cu/man year i.e. 3 times more. Production, productivity of inputs and of personnel therefore have to be improved at medium and long term. Again, foreign technology and finance is sought for this.

[19] Data is available in the data room on the Boshikul orebody (geological monography) and the project of development of mine and concentration plant.

8. COPPER RESOURCES

8.1 COPPER RESOURCES OWNED BY BALKHASHMED

8.1.1 KOUNRAD OPERATING MINE

Kounrad, located 15km north east of Balkhash, was developed in the 1930s. It is a major copper molybdenum porphyry orebody of the disseminated type. Average grade is 0.35% Cu above the cut-off grade of 0.25% Cu. The orebody, with a carrot form extending almost vertically downwards, is exploited openpit by a system of railway similar to Bingham in the USA. Remaining reserves as of end 1994 are 0.1Mt Cu contained in approx. 30 Mt of ore down to level 330m plus 0.6 Mt Cu (in approx. 180 Mt) down to level 500m. To tap the reserves between 330m and 500m requires pit expansion work, therefore mining of additional waste rock. This represents operating cost for additional waste removal which will be counted as investments in the accounts, in order not to increase the cost of production per tonne of ore fed to theconcentrator.

The following table indicates the main operating parameters of Kounrad mine over the past 5 years.

Kounrad Mine						
reserves Mt Cu	0.7					
A	0.1					
B	0.6					
C						
of which sulphides %	90%					
of which oxides %	10%					
operating parameters	**1994**	**1993**	**1992**	**1991**	**1990**	**1989**
ore Mt/annum	5.37	7.48	8.15	7.30	8.63	10.40
% Cu	0.38%	0.38%	0.39%	0.40%	0.42%	0.42%
Cu t	20 417	28 648	31 541	29 346	35 901	43 888
% Mo						
OB Mm3	7.98					
density t/m3	2.80					
OB Mt/annum	22.33					
OB/ore	2.99					
total excav/t of ore	3.99					
distance of transport km	15					
wagon payload	105					
trains tonnes/unit	2 100					
diameter of the orebody	1500-1800m					
bench height m	15					
depth of pit m	330	ultimate pit at 510m depth				
List of main equipment						
Electric shovels 8-10m3 ore & waste extraction	9					
drills SBH 250	5					
transport by trains electric locomotives	5 wagons					
mineral composition of the ore						
sulphides						
pyrites						
chalcopyrite $CuFeS_2$						
bornite Cu_5FeS_4						
Molybdenite MoS_2						
galenites, marcassites						
secondary sulphides						
chalcosite Cu_2S						
covellite CuS						
oxydes						
malachite $CuCO_3,Cu(OH)_2$						
azurite $2CuCO_3,Cu(OH)_2$						
chrysocolle $CuSiO_2,2H_2O$						
oxides recovery R & D						
oxide leaching and cementation from stockp (25000t pilot test)	1500-2000t Cu content; in cement 45-60%Cu; J Earth resources of USA.					

8.1.2 SAYAK OPERATING MINE

The Sayak orebodies are situated 200km east of Balkhash near the railway linking Balkhash to the Semipalatinsk and Ust Kamenogorsk region.

Sayak was developed in the mid 1960s to enhance the supply of copper raw materials. This is a skarn type of orebody, in the form of lenses. The deposit has been exploited since the early 1970s. Remaining economic reserve is 0.10 Mt Cu contained in some 8.4 Mt of ore at 1.16% Cu. It is considered that due to transport, the mine will not extend beyond eight years of exploitation. However, there are more reserves left (estimation 1.2 Mt Cu). Because Sayak is located 80 km north of lake Balkhash and has no water, it has not been considered so far feasible to build a concentrator.

The following table shows main parameters of operation over the past 5 years.

Sayak mine						
reserves Mt Cu	0.10					
A						
B						
C						
operating parameters	**1994**	**1993**	**1992**	**1991**	**1990**	**1989**
ore Mt/annum	1.95	2.32	2.30	2.18	2.65	3.13
OB m3						
OB/ore m3/t						
distance of transport	200					
wagon payload	105					
% Cu	0.68%	0.60%	0.67%	0.66%	0.72%	0.75%
Cu t	13 274	13 920	15 341	14 388	18 974	23 600
mineral composition						
sulphides						
chalcopyrite						
bornite						
covellite						
oxydes						
magnetite (20-40%)						

In addition to copper ore, Sayak produces ornemental marble in slabs, plates and blocks for the construction industry and for monuments.

8.1.3 CONCENTRATION OF KOUNRAD AND SAYAK ORES AT BALKHASHMED CONCENTRATOR

Balkhash concentration plant was first developed in the mid 1930s to concentrate the copper ores mined from Kounrad. Plant construction started in 1936 and was completed in early 1940.

In 1966 the concentration plant was expanded twofold and its circuits were adapted to treat ores from Sayak.

Kounrad orebody is characterized by mineral composition: 90% sulphides: pyrites, chalcopyrites, bornites, covellites, chalcocites, molybdenites. 10% oxides: malachites, azurites, chrysocolle. Average grade of ore mined (above a cut-off grade of 0.3%Cu) is 0.40-0.45% Cu. During the first half of 1994 the mine extracted 2.5 Mt.

Sayak ores require a different treatment for concentration. Main minerals present are chalcopyrites, bornites, covellites, and there is also presence of magnetites (20-40%) as well as gold, silver, selenium, cobalt and molybdenum minerals.

The concentrating plant is comprised of a wagon tippling section which discharges into the primary crusher (cone crusher type KKD 1500/180mm, 1150m3/hour) which reduces size from max 1300mm to 350mm. From there crushed ores are sent to secondary and tertiary crushing sections, (intermediate storage facilities can be used if necessary). After tertiary crushing the ore is sent to the milling and flotation sections.

There are 7 sections; sections 1 to 4 are for treating Kounrad ores, sections 6 and 7 are for Sayak ore (autogenous grinding). Section 5 can be used for Kounrad and or Sayak. Section 7 can be used to concentrate copper slags recycled from the smelters.

Production of the plant is copper concentrates, and pyrite concentrates. Up to recently, selective concentrates of molybdenum and of magnetite were also produced. These productions had to be discontinued recently because of lack of markets following the disintegration of the USSR. Molybenum concentrates (18-24% Mo) were obtained by selective flotation of Cu/Mo bulk concentrates and were sold to Tcheliabinsk metallurgical combinate in East Urals region of Russia. The magnetite concentrates were obtained from the Sayaak ores and were sold to Temir Taou combinate and Chimkent in Kazakhstan.

The concentrates are thickened in eight 30m dia thickeners and then delivered in pulp form to the concentrate preparation section of the metallurgical complex.

Tailings of the plant are transported by pipeline to the tailings dumps loacted near lake Balkhash along Bertys bay. All the water is recovered and recycled to the plant. The waste dump area is protected from the lake by thick and deep embankments.

The general state of the concentrator is good, but some maintenance and replacements are desirable in the flotation cell section, for pumps and in the milling section, in order to upgrade productivity.

The following table shows the main operating parameters of the plant over the past 5 years.

Balkhashmed concentration plant operating data

years	1989	1990	1991	1992	1993	1994
total feed (000ts)	**13 637.5**	**11 381.0**	**9 498.8**	**10 474.5**	**9 887.1**	**7 675.4**
Kounrad (000ts)	10 399.6	8 629.6	7 303.5	8 149.3	7 481.2	5 404.4
Sayak (000ts)	3 135.3	2 648.8	2 182.2	2 297.7	2 317.5	2 002.8
copper slags external (000ts)	74.7	94.3	13.1	27.5	88.0	267.6
other sources (000ts) (balance)	27.9	8.3			0.4	0.6
mean grade Cu %	**0.51%**	**0.52%**	**0.46%**	**0.45%**	**0.44%**	**0.46%**
Kounrad Cu %	0.42%	0.42%	0.40%	0.39%	0.38%	0.38%
Sayak Cu %	0.75%	0.72%	0.66%	0.67%	0.61%	0.61%
copper slags external Cu %	1.39%	1.59%	2.42%	2.36%	0.98%	0.98%
other sources Cu %	2.50%	29.50%			23.26%	23.26%
concentrates (000ts)	**365.8**	**294.5**	**237.6**	**261.9**	**226.6**	**188.7**
Kounrad (000ts)	222.4	177.7	156.0	182.3	150.5	113.4
Sayak (000ts)	136.5	108.5	80.4	77.4	72.7	60.6
copper slags external (000ts)	4.6	7.0	1.2	2.2	3.1	14.6
other sources (000ts)	2.3	1.3			0.4	0.1
concentrate grade % Cu	**15.58%**	**15.87%**	**14.55%**	**13.79%**	**14.00%**	**14.86%**
Kounrad Cu %	15.48%	15.68%	13.91%	12.26%	12.48%	12.51%
Sayak Cu %	15.78%	16.00%	15.74%	17.29%	16.98%	18.50%
copper slags Cu %	15.24%	16.23%	18.67%	17.50%	16.30%	18.00%
other sources Cu %	13.98%	29.50%			24.40%	22.00%
metal recovery rates %	**82.27%**	**79.47%**	**78.45%**	**76.00%**	**72.67%**	**78.80%**
Kounrad %	78.44%	77.62%	73.93%	70.86%	65.54%	68.54%
Sayak %	91.10%	91.51%	87.84%	87.30%	87.90%	87.34%
copper slags %	67.20%	75.60%	70.51%	59.20%	58.77%	60.00%
other sources %	71.05%	64.20%			83.75%	71.40%
rejects % Cu	**0.09%**	**0.09%**	**0.10%**	**0.11%**	**0.12%**	**13.00%**
Cu t						
Kounrad	34 424	27 865	21 706	22 348	18 779	14 186
Sayak	21 540	17 355	12 651	13 379	12 345	11 211

Costs of mining and concentration (Kounrad and Sayak ores):

The following table shows the structure of costs of mining and concentration for the three first quarters of 1994.

Mine costs	Sayak mine	Kounrad	Total
	1994	1994	1994
Mt ore	1.952	5.373	7.325
Cu %	0.68%	0.38%	0.46%
Cu content t	13 273	20 417	33 691
Mm3 waste	2.809	6.056	8.865
density ore	2.8	2.8	2.8
Mm3 total extraction	3.506	7.975	11.481
average m3/t ratio waste	1.44	1.13	1.21
average m3/t ratio total extraction	1.80	1.48	1.57
total cost ore Te (000)	155 793	52 164	207 957
total cost waste Te (000)	106 042	135 058	241 100
total cost Te (000)	261 835	187 222	449 057
cost/tonne ore Te	79.81	9.71	28.39
cost/m3 wasteTe	37.75	22.30	27.20
cost/m3 total extraction Te	74.68	23.48	39.11
cost/tonne ore US$	2.34	0.28	0.83
cost/m3 waste US$	1.11	0.65	0.80
cost/m3 total extraction US$	2.19	0.69	1.14
total cost/t ore extracted US$	3.93	1.02	1.79
number of operating personnel	910	1 099	2 009
cost/man year Te	44 976	44 976	44 976
personnel cost ore Te (000)	2 039	4 501	6 540
personnel cost waste Te (000)	4 856	13 468	18 324
personnel cost support facilities Te (000)	34 033	31 460	65 493
personnel cost total Te (000)	40 928	49 429	90 357
cost of transport Te/t	51.28	3.00	15.87
cost of transport US$/t	1.50	0.09	0.46
cost of transport of ore Te (000)	100 096	16 119	116 215
cost of concentration Te/t	109.83	109.83	109.83
cost of concentration US$/t	3.22	3.22	3.22
cost of concentration Te (000)	214 391	590 139	804 530
total cost Te(000)	576 322	793 480	1 369 802
average total cost/t ore mined & treated Te	295.3	147.7	187.0
Te/US$ (average over period)	34.16	34.16	34.16
total cost US$ (000)	16 871	23 228	40 100
total cost US$/t extracted, transported & treate	8.64	4.32	5.47
average cost/t Cu content US$	1 271	1 138	1 190
average cost/lb Cu content US$	0.58	0.52	0.54
average recovery concentration plant 1994	88.0%	70.0%	74.8%
overall Cu produced tonnes	11 680	14 292	25 973
grade of concentrates % Cu	17.0%	12.5%	14.2%
t of concentrates required	68 709	114 337	183 046
average cost/lb Cu delivered US$	0.66	0.74	0.72

By relating these costs to copper content (in lb) of the concentrate produced from one tonne of ore (mean characteristics) for the same period, one finds that the average cost is 0.72 US$/lb. This is above the median cost of copper mined and concentrated by flotation in the world (0.60 US$/lb Cu).

8.1.4 BOSHIKUL MINE AND CONCENTRATOR PROJECT

Boshikul orebody is located in Ekibastuz district of Pavlodar region, 100km from the town of Ekibastuz, 18km north of Boshikul railway station. The orebody is fully explored and ready for exploitation. It is a copper porphyry type in the form of a massive body. Reseve is 2.14Mt Cu in 400Mt ore at 0.5% Cu, of which 1.2 Mt Cu in categories A+B+C1.

Technical-economic data on Boshikul projected mine and concentrator plant are presented available in the data-room. The following table is an extract of the most salient points of the project report.

Parameters	units	project 1992	project revis 1994
Ore production :	Mtpa	9.0	7.0
ore grade Cu	%	0.64%	0.73%
ore grade Mo	%	1.00%	1.00%
ore grade Au	g /t	0.216	0.247
ore grade Ag	g /t	7.18	8.07
Production of concentrates:			
Cu (yeld & tonnage)	% /t	3.00 /270000	3.132 /219240
Mo semi-product	% /t	0.08 /7200	
Metal grade in concentrates:			
a) in Cu concentrate			
Cu	% /t	17.29 /46683	18.68 /40954
Mo	% /t		0.23 /504.2
Au	g/t	3.95	3.94
Ag	g/t	167.53	180.36
b) in Mo-product			
Mo	% /t	8.78 /632	
Rate of recovery:			
a) in Cu concentrate			
Cu	%	81.57%	80.71%
Mo	%		72.25%
Au	%	54.86%	50.00%
Ag	%	70.00%	70.00%
b) in Mo-concentrate			
Mo	%	70.25%	
Expenses per tonne of ore:			
1) electricity	kWh	35.3	27.6 /29.6
of which:			
plant	kWh	32.5	24.7 /26.7
tailings & recycling of water	kWh	2.80	2.90
2) fresh water	m3	0.50	0.50
3) recycl. water	m3	3.50	2.55 /2.56
4) spare parts:			
steel	kg	0.21	0.13
rubber	kg	0.01	0.01
5) milling balls	kg	1.20	0.94
Number of personel	persons	389	240 /247
Productivity of labour	t	23 136	29167 /28340
Construction volumes:			
on main buildings:			
1) for primary crushiung	m3	50800	41500
2) storage ofcrushed ore:			
undeground part	m3	59400	15600
on surface part	m3	53600	3500
3) main building	m3	634000	345000
4) filtration section	m3	114800	63200
5) filtration & drying section	m3		84500
6) reagent preparation section	m3	64800	64800
Data on teilings:			
1) main pulp lines			
tubes	km.	25	12.5
ground works	mln.m3	0.36	0.33
2) local pulp lines			
tubes	km.	21.3	10.1
ground works	mln.m3	1.3	0.6
Investments	mln. $	127	93.6 /94.3
Cost for 1t. of ore treatment	$	5.11	4.78 /4.87

NB: The total investment cost of the mine and concentrator project is estimated to be 235 M US$.for

8.1.4.1 ***BASIC DATA***

Location of concentration plant and tailings dump, including system for recycling of waste water to the plant, will take place 23 km N from the railway station of Boshekul, in Pavlodar region.

Buildings, plant and equipment will be installed on an industrial area together with mining equipment and auxiliary units.

Ore base for the complex is Cu Mo ores of Boshekul orebody. Mining of ore will be by open pit with transportation of ore by trucks.

According to the treatment plant's process, caolinised and sulfide ores will be treated separately. In the future, the plant will treat sulfides only.

Technology of treatment had been selected based on results of semi-industrial tests.

8.1.4.2 ***PRELIMINARY GENERAL PLAN, LIST OF MAIN PLANT AND EQUIPMENT AND BOUNDARIES OF THE CONCENTRATOR PROJECT.***

Main buildings, plant and equipment of the concentrator are the following:

1. primary crusher building:
2. storage of crushed ore;
3. concentrator building;
4. filtration unit and storage of concentrates building;
5. reagent preparation building;
6. tailings dump with system of hydro-transport and recycling of water system.

The project of all the units and buildings was prepared by the non ferrous metals Institute 'Sredazniprotsvetmet" (Tashkent). All the geological data ar e available at the Ministry of Geology and Preservation of Earth Resources of Kazakhstan.

8.1.4.3 ***TECHNOLOGY AND LIST OF MAIN EQUIPMENT.***

The technology consists of :

- primary crushing of ore transported from the openpit mine;
- separate storage of crushed caolinized and sulfide ores;
- separate treatment of two sorts of ore in separate treatment lines;
- water removal from the concentrates and their transportation by rail to Balkhash;

- reception and preparation of reagents;
- system of tailings hydro-transportation and recycling of waste water to the plant.

List of main equipment of the concentrator (see table below).:

N°	Main technological equipments	Number of equipment	name of supplier
1	Crushers	2	Russia, "Volgocehmach" "Allis Mineral" (G.B.)
2	Mill for halfcrushing MPS 9.7*7.4, volu 330m3	2	"Allis Mineral" (G.B.)
3	Ball mill MSC 5*6, volume 190m3	2	"Allis Mineral" (G.B.)
4	Ball mill MSC 4.0*5.5, volume 60m3	2	Ukraine
5	Ball mill MSC 3.2*3.1, volume 22m3, 4m3	2	Russia, "Uralmash"
6	Ball mill MSC 2.1*3.0, volume 8.5m3	1	Russia, "Uralmash"
7	Inertial crusher KID-900, 100m9/hour	4	Russia
8	Flotomachines:	cells	
	OK-50	78	Finland, Outukumpu
	OK-8	33	
	OK-3I	93	
	FMR-1.2	14	Ukraine
	FMR-0.4	14	
9	Hydrocyclones battery		England, "Warman"
	660mm.	36	
	380mm.	12	
10	Electric pumps		"Allis Mineral" (G.B.)
	16/14AN - 2500m3/hour	2	
	14/12AN - 188m3/hour	4	
	12/10AN - 1200m3/hour	2	
	10/8AN - 800m3/hour	6	
	8/6AN - 500m3/hour	4	
11	Air pump CNV-800/1.6, 800m3/hour, atm.	4	Russia
12	Radial thickener	3	Russia
13	Vacuum ceramic filters		
	30m2	3	Finland, Outukumpu
	15m2	2	
14	Strip transporters	12	Russia
	B-1600mm.		
	B-1200mm.		
	B-800mm.		
15	Feeders 1300mm.	8	Russia
16	System of automatisation of techn. pro analysis & dosation of reagents		Finland, Outukumpu

The project is based on equipment and materials procured from the CIS, except the following:

- mills for autogenous crushing and ball mills in ore cycle;
- flotation cells;
- ceramic vacuum filters;
- pumps for the ore cycle and hydro-transportation;
- system of express analyses, including dosing of reagents and automatic control.

Final choice of equipment will be made after basic engineering studies.

8.1.4.4 ELECTRICITY SUPPLY

Supply with electricity from substation 220/35/6 kV, voltage of the line is 220 kV.

Outside voltage 220 kV, inside voltage 10 and 6 kV.

Feeding circuits with voltage 660 V and 300 V, light 220 V.

Numbers of sketches of electricity supply are available in the detailed report.

8.1.4.5 AUTOMATIZATION OF TECHNOLOGICAL PROCESSES.

Automatic system of managment of technological processes of flotation plant is based on modern means of collection, transportation and analysis of information.

Structure of system of management of concentration plant is given on picture 1.

8.1.4.6 LOCAL CONDITIONS OF THE INDUSTRIAL AREA

8.1.4.7 CLIMATE

- normal snow covering 100 kg/m2;
- pressure of the wind at altitude 10 m above ground level is 45 kg/m2;
- minimum temperature -36°C;
- depth of soil freezing is 2.4 m.

8.2 OTHER SOURCES OF RAW MATERIALS

8.2.1 COPPER

Thanks to the favourable geological environment of Kazakhstan, there are abundant national resources to enable Balkashmed to rely increasingly and durably on national reserves for copper, as well as by-product precious metals. These are currently state-owned properties, fully explored, but yet to be developed.

The main characteristics of some of these ore bodies are set out below :

- *Actogay orebody* is in Semipalatinsk region 20 km east of Actogay railway station, 420 km east of Balkhash. This is also a copper molybdenum porphyry orebody in the form of disseminated mineralisations. The orebody is fully explored. Copper reserve is approx. 5.9 Mt Cu in 1 475 Mt ore at 0.40% Cu. Gold reserve is 44 t which corresponds to a grade of 0.03 g/t.
- A*idarlay* orebody, situated near Actogay, has similar characteristics as Actogay. The orebody is also fully explored. Copper reserve is approx. 5.8 Mt Cu in 1 450 Mt ore at 0.40% Cu. Gold reserve is 14 t which corresponds to a grade of 0.01 g/t.

These two orebodies are the largest of all; in addition to Cu, Au and silver (Au/Ag ratio is >10), they contain a substantial cover of oxidized materials in addition to the above cited tonnage, which is amenable to acid leaching and SX/EW processing, for which Balkhashmed have a project.

- *Karatas orebody* 100 km north of Balkhash, is also a fully explored orebody. It contains copper and molybdenum disseminated ores in vertical to subvertical veins of irregular form. There are four areas which contain a total of 0.25 Mt Cu in 77 Mt of ore at 0.33% Cu, and 28 000 t Mo at 0.04% Mo.
- Kusmurun and Akbastau orebodies, located 160 km north of Balkhash, contain 0.8 Mt Cu in ore at 2.9% Cu. Concentrate grade according to Balkhashmed would be 18-20% Cu.
- Koktau: Koktau orebody (and Chilisay concentrator), is situated north west of Balkhash. It contains 0.7 Mt Cu in ore at 1.83% Cu. Concentrate grade according to Balkhashmed would be 22% Cu.
- Koksai: this is a porphyry copper orebody which is situated in Taldy-Korgan region, 150 km NE from Almaty, 70 km S from Taldykorgan. Cu reserves are 0.8 Mt Cu in ore A+B+C1 1 639.6 kt; by-products are: Au 37 159 kg, Ag 396 t, Se 1 121 t, Re 177 t, Te 355t, Mo 15.7 kt.

8.2.2 PRECIOUS METALS

In addition to these copper resources with by-product Au and Ag, there are auriferous ores from gold orebodies proper, and mines and concentrators (the gold and silver being contained in quartzites which used as a Si02 flux in the smelting process). These ores come from the following orebodies (Ag estimated on the basis of an assumed Ag/Au ratio of 12:1):

	Au	**Ag**
Zharkulak	7 t	84 t
Muzbel	20 t	240 t
Kenzhem	43 t	416 t
total	70 t	840 t.

8.3 CONCLUSIONS ON COPPER RESOURCES

Taking into consideration both Balkhashmed's own resources and the other current Kaza kh sources of supply, domestic supply can amount to approx. 80% of the requirement at current level of cathode production, as shown in the table below.

Cu sources of supply	t Cu	% of supply
Kounrad concentrates	20 000	14.0%
Sayak concentrates	8 000	5.6%
Boshikul concentrates own	39 000	27.3%
Balkhash concentrates	67 000	46.9%
Kazakhstan concentrates	23 000	16.1%
shortfall (or excess)	26 000	18.2%
Cu mattes & scraps Kazakhstan	12 000	8.4%
Cu blister Irtych custom refined	15 000	10.5%
total Cu supply	143 000	100.0%
average yield supply/cathodes	94.5%	
total Cu produced cathodes	135 135	

This does not take into account additional sources of domestic supply which are in the process of development and which may be available in the future, in particular the major orebodies of Actogay and Aidarlay.

9. INVESTMENTS REQUIRED

The following is a list of main investment projects considered by Balkhashmed:

Capacity increase is required for the abatement of SO2 gases and sulphuric acid production. However, increased acid production will pose problems of marketing, because the traditional outlets (uranium leaching in ex-USSR) are now drastically reduced. To replace such outlets it is considered to develop hydrometallurgy in mining, that is the treatment of oxides and low grade sulphide ores. A JV with the American company Earth Resources Inc of Texas has been arranged for this purpose. The American company is to provide technology and funds to purchase the necssary equipment.

There are leachable ores at Kounrad (59Mt of oxide stocks in the waste near the pit) and if the mine mine deepens, there will more (oxides are found on the periphery of the orebody down to 130m depth and secondary sulphides below). Pilot testing has already been completed and the results obtained sofar have been promising.

The development of other uses of sulpuric acid e.g. ammonium sulfate, a low grade nitrogenous fertiliser, may also be necessary. A JV has been entered for such a development with a Swiss company. It depends on the availability of ammonia, and on the marketing of ammonium sulfate to the agricultural sector. An amount of 10MUS$ is earmarked for this project.

As mentioned previously, some of the process divisions require some revamping, or modernisation of plant and equipment. This is necessary to bring the combinate up to international levels of productivity of factors (capital, inputs and personnel).

The cost of revamping of the existing industrial buildings and plant and equipment has been estimated with the following method (see following table):

Revamping of buildings, plant & equipment	KTE (000s)	$ (000s)	$/lb Cu year	**capacity**	
value of buildings as of 1/7/94 (000s)	10 574 000	244 260	***0.37***	kt Cu	Mlb Cu/annum
value of plant & equipment as of 1/7/94	43 199 064	997 899	***1.51***	300	661.50
total (000s) rounded	53 773 000	1 242 000	***1.88***	1.88	0.09
estimated wear of buildings as of 1/7/94 %		*35%*		**reference Thailand**	
estimated wear of plant & equipment as of 1/7/94 %		*25%*		$ (000s)	kt Cu
cost of revamping & correcting wear ($ 000s)		340 000	***0.51***	520 000	150
of which buildings (rounded)		90 000	***0.14***	$/lb Cu year	$/lb Cu 20 years
of which plant & equipment (rounded)		250 000	***0.38***	1.57	0.08

The method yields an estimate of 340 MUS$ for the revamping of plant and equipment.

In addition, major investment items have to be added as listed below, including investments already initiated and still to be completed (copper transformation plant and the gold and silver refining plant):

cost of revamping & correcting wear ($ 000s)		340 000	***0.51***
capital acquisitions in the past 3 years (*)		70 000	***0.11***
balance on investments in progress		50 000	***0.08***
Balkhasmed's major development projects:		50 000	***0.08***
Vanujkov smelter revamping and modernisation		20 000	***0.03***
Sulphuric acid plant 100 000tpa (		20 000	***0.03***
Bozshikul mine development, flotation plant, for reminder considered as a separate item in mining and concentration		*rem 250 000*	
ammonium sulfate plant for H2SO4 uses enhancement		10 000	***0.02***
grand total capital investments US$ (000s)		510 000	***0.77***

(*) copper transformation plant, and gold and silver refining plant.