



# Copper: reserves, mining and processing in CIS countries

By Mikhail Burstein

**In this article Mikhail Burstein describes the situation of the copper industry in the former CIS-countries. Today the Russian federation accounts for 53 per cent of the estimated reserves and for 59 per cent of the copper production in the region. Important reserves are also found in Kazakhstan, Uzbekistan, Tajikistan, Azerbaijan, Armenia and Georgia.**

There are more than 240 copper deposits on the territory of the former USSR., including more than 110 major copper deposits. The main reserves of copper are the sandstone-hosted copper or Red Bed type (30 per cent), porphyry copper type (14 per cent), gabbroid-associated Ni-Cu type deposits (31 per cent), and Cu-rich massive sulphide type (21 per cent) ores. Minor deposits of copper in skarn and associated to quartz-veins are also mined (4 per cent).

Red bed copper deposits (Jezkazghanskoye, Udokanskoye etc.) are sediment-hosted disseminated copper mineralizations with 3 to 15 per cent copper minerals, mainly chalcopyrite, bornite and chalcocite.

The massive sulphide deposits (e.g. Uchalinskoye, Sibaiskoye, Gayskoye, etc.) are rich in pyrite with varying copper and zinc content, and accessory metals like gold, silver etc. The Ural deposits are difficult to process depending on the fine grain of the intergrown sulphide minerals and colloform textures.

The most important copper prospects are found in Russia, Kazakhstan, Uzbekistan, Tajikistan, Kyrgyzstan, Azerbaijan, Armenia and Georgia. The Russian Federation accounts for 53 per cent of the estimated reserves and about 59 per cent of actual copper production. In total there are 118 thoroughly investigated copper deposits in Russia, including 67 major deposits. The most important commercial deposits are the Udokanskoye deposit (a sandstone-hosted type) located in the Chita region, Talnakhsokoye and Oktyabrskoye (copper-nickel sulphide deposits) in the Krasnoyarsk territory and the Gayskoye deposit (a massive copper-pyrite deposit) in the Orenburg region.

In total 47 deposits in Russia are mined for their copper content. The main mining districts are in the Norilsky region, the Ural region and the Bashkortostan region. The five largest deposits are Zhdanovskoye (Kola peninsula), Gayskoye, Volkovskoye (the Urals), Talnakhsokoye, Oktyabrskoye (Krasnoyarsk territory). The largest reserves are in the deposits of Kyzyl-

Dere (North Caucasus), Podolskoye, Safyanovskoye, (Ural), Udokanskoye (Chita).

Copper ore is mined and processed at 16 Russian centres:

- the Urupsky mining and beneficiation complex in North Caucasus ;
- the Pechenga nickel-complex in the Kola Peninsula;
- the Degtyarskoye and Buribayevskoye mining departments, the Gaysky and Uchalinsky mining and beneficiation complexes, the Karabashsky, Kirovgradsky and Krasnoyarsky copper smelters, the Sredneuralsky copper smelter (SUMZ) and the Bashkirsky copper-sulphur complex, all in the Uralsky region;
- the Altaysky mining and beneficiation complex in the Altay Territory;
- the Norilsky mining and metallurgical centre and the Sorsky Cu-Mo complex in the Krasnoyarsk region;
- the Primorsky and Solnechnogorsky mining and beneficiation complexes in the Far East.

In 1992, Russian mining and beneficiation complexes produced a total of 821 kt of copper concentrate with an average copper grade of 16.5 per cent. This is 94 kt less than in 1991, and 159 kt less than in 1990. In 1992 further 5 690 kt of copper-nickel concentrate was produced.

It should be stressed that though some enterprises reduced copper concentrate production volumes considerably in 1992 as compared to 1990 and 1991 (Gaysky, Uchalinsky, Altaysky mining and beneficiation complexes, Sredneuralsky and Kirovgradsky copper smelters), there are enterprises which increased concentrate production volume (Krasnoyarsky copper smelter, Buribayevskoye mine department, Bashkirsky copper-sulphur complex, Sorsky copper-molybdenum complex, Solnechny mining and beneficiation complex). Some of the later enterprises increased production considerably. For example, at Sorsky complex the increase was 15.9 per cent as compared to 1986, 36.5 per cent as compared to 1990 and 13.1 per cent as compared to 1991.

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**Major copper mines and smelters (refineries) in the former Soviet union.**

The largest Russian copper concentrate producer is Norilsky Nickel Concern which comprises Norilsky mining and metallurgical complex and Pechenganickel complex (66.3 per cent), the second and the third largest producers are Gaysky (9.1 per cent) and Uchalinsky (6.4 per cent) complexes.

Rough and refined copper is produced by 10 Russian enterprises

- in Uralsky region these are Krasnouralsky, Sredneuralsky, Karabashsky, Kyshtymsky and Kirovogradsky copper smelters, Mednogorsky copper sulphur complex Uralelectromed Industrial Association;
- at Kola peninsula it is Severonickel and Pechenganickel complex;
- in the Krasnoyarsk territory it is Norilsky mining and metallurgical complex.

Other copper products (matte, cake, etc.) are produced by Chelyabinsky electrolytic zinc plant (Chelyabinsk region), Electro-zinc plant (North Caucasus), lead plant of Dalpolymetal Association (Primorye), Karabashsky copper plant (Urals), Norilsky mining and metallurgical complex and Pechenganickel complex.

In 1992 a total of about 273 kt of rough copper was produced in Russia which is by 37 kt less than in 1991 and 111 kt less than in 1990. Though ore production volumes were reduced at all plants of the Urals, Sredneuralsky copper smelter is the largest producer of rough copper (42 per cent).

In 1992 refined ore production was in 1992 at 482 kt which is by 27 kt higher than in 1991 and by 7 kt lower than in 1990. The main refined ore producers are Norilsky Nickel concern (65.3 per cent), Severo-

nickel Association (15.1 per cent) and Uralelectromed Association (19.6 per cent).

Refined ore production increased sharply at Uralelectromed Association. The increase was 81 per cent as compared to 1986, 203 per cent as compared to 1990, 240 per cent as compared to 1991. At Kyshtymsky electrolytic plant, Uralelectromed Association, a circuit for refined copper production was put in operation June 1993 (copper grade is 99.99 per cent). Equipment Outokumpu company (Finland) installed in the new circuit. A production level of 70 kt of metal per annum is to be reached in 1993.

Unlike Kazakhstan, where most of the concentrates are of the highest grade, Russia could until recently produce only low-grade concentrates. Introduction of addi-



### *Mining city in Siberia 1993.*

tional up-to-date circuits for refined copper production allows a certain reduction of high-grade copper shortage. Simultaneous changes take place in the Russian structure of copper consumption, dynamics of its import and export by the CIS countries. There is a trend of increasing both the share of copper production and metal export to the former USSR countries.

It should be noted that the main copper producers Russia and Kazakhstan have been processing imported concentrates for a long time, supplied by Mongolia and Chile. At present the import is decreasing considerably. 100 kt of copper were produced from the concentrates (about 300 kt) imported by Russia (together with Kazakhstan) in the second part of 1992. However, this could be the last large export supplies,

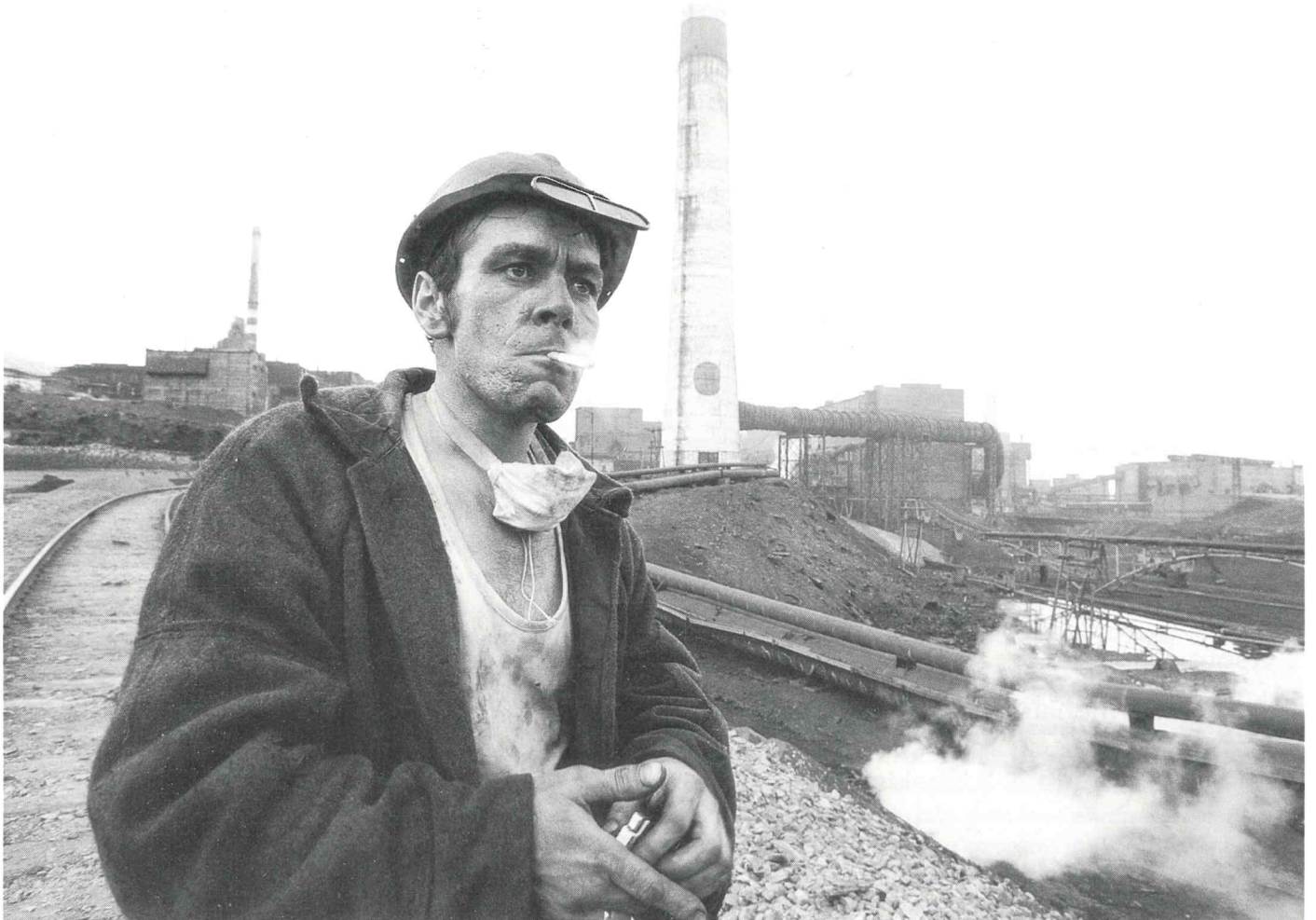
and the volume of copper production from imported concentrates is likely to drop considerably. It should be also taken into account that the cost of copper production in Russia has been growing. Imported teed processing in Russia can become non profitable in 1993 .

Therefore, the Russian copper industry can only solve the problem of raw copper shortage based on its own resources. In 1990-1992 mining at Tash-Tall (Bashkirsky copper-sulphur complex) and Uzelginsky (Uchalinsky mining and beneficiation complex) were begun. Of the developed deposits the following are working: Podolskoye (Bashkirsky copper-sulphur complex), and Novo-Shaitanskoye (Kirovgradsky copper smelter). Because of the current financial problems in Russia ore mining at

these deposits is only possible with foreign investments.

Of considerable interest are the following Russian deposits: Yubileynoye (Beshkortostan), Komsomolskoye (Orenburg region) and Safyanovskoye (Sverdlovsk region).

Udokanskoye deposit of cupreous sandstone is of special significance. Reserves of commercial-grade A+B+C1 category were evaluated by the State Committee on Resources at 11 223 Mt of copper. The copper content in the currently mined reserves is 1.61 per cent. A licence for the development of the deposit was granted to Udokansky mining company. According to the conditions of the licence, the main production facilities are to be put into operation by 1997. At the first stage a copper



*Dzhezkasgan  
in the present Kazakstahn, 1966.*

concentrate production volume of 300 kt per annum (70 per cent of concentrate) is to be sold to China, 30 per cent of concentrate is to be left in Russia. Later the volume of concentrate production is to be brought to 475 kt per annum and the share of China is to be reduced to 50 per cent. In 6-7 years a consistent additional supply can then be provided of 250-300 kt of concentrate to Russian copper smelters.

According to experts, the Australian BHP company did not win the tender for Udokanskoye deposit development for the following main reasons:

- a too short period for work on the project;
- limited access to geological information on the deposit;

- insufficient orientation about the Russian industry.

In conclusion the Russian production of copper will probably drop further in 1994. The present position in the world copper market will be changed.

Analysis of the data on copper export and import allows a conclusion on a sharp increase of rough copper export. This is explained by accumulation of large stocks of copper in 1992 it was 387 kt, in 1991 it was 19 kt within the CIS-countries.

As the cost of copper production increases, the copper prices in Russia increase. In April 1993 the price was 800-880 USD, by October it increased to 1 200-1 300 USD.

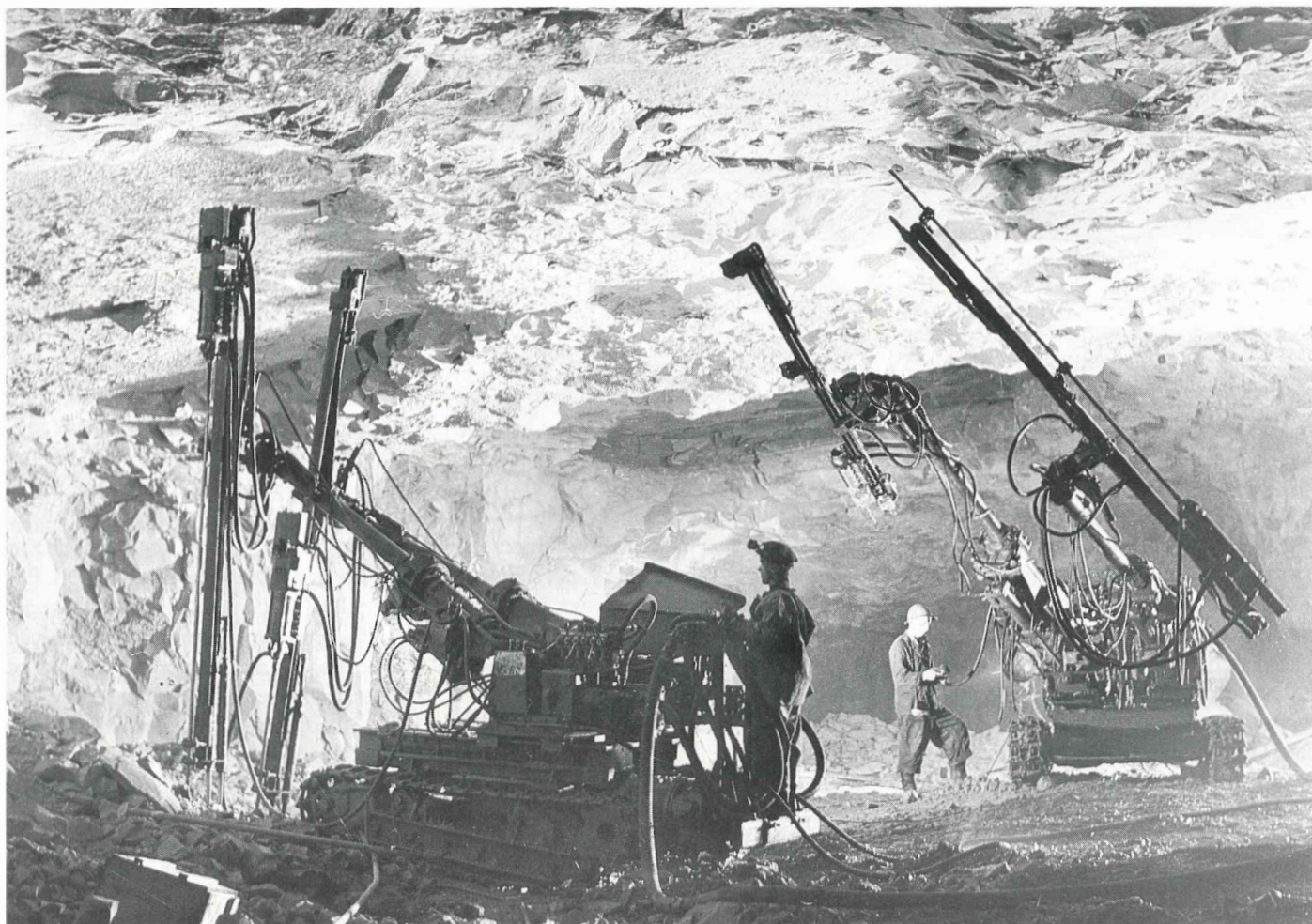
With the general increase of the copper price in Russia, a higher growth rate can be

expected for refined copper consignments licensed for export. Already in February 1993 the demand price for refined copper licensed for export approached closely the world level (up to 1 800 USD/t copper).

### **Kazakhstan**

In Kazakhstan the copper reserves amounts to 29 per cent, and the copper production to 30 per cent of the total of the former USSR states. The reserves are confined to 74 deposits, out of which 32 major copper deposits contain 87 per cent of the total reserves of Kazakhstan.

The explored and estimated reserves within the mines constitute 35 per cent of the total copper resources in Kazakhstan. The estimated reserves of deposits, currently being developed for mining, corre-



*Mineworkers in the former Soviet Union.*



sponds to 11 per cent of the total reserves. Other investigated reserves hold 48 per cent of the reserves, while the remaining 6 per cent is currently under exploration.

The prevailing type of copper-bearing deposits are sandstone-hosted copper (29 per cent) and porphyry copper (42 per cent). Among the largest deposits is the Jezkazghanskoye which is located in copper-bearing sandstones. Aktogayskoye and Aydarly deposits are of copper-porphyry type.

The mining and processing enterprises that produce copper concentrate in Kazakhstan are as follows: Industrial Associations Jezkazghantsvetmet and Balkhashmed, East-Kazakhstansky copper-chemical complex., Irtyshsky and Leninogorsky polymetallic complexes, Zyryanovsky lead-zinc complex, Zhezkentsky and Zhay-

remsky mining and beneficiation complexes.

The main copper concentrate producers in Kazakhstan are Jezkazghantsvetmet Association (64 per cent of feed supplies to Kazakhstan copper smelters) and Balkhashmed Association (14.3 per cent).

Rough and refined copper are produced by Jezkazghantsvetmet and Balkhashmed Associations, and Irtyshsky polymetallic complex. Balkhashmed Association produces 54 per cent of refined copper in Kazakhstan, Jezkazghantsvetmet produces 46 per cent of refined copper.

It should be noted that the Kazakhstan refined copper is a high-grade product which is highly competitive in the international market. Thus, mark A was again applied to products of Jezkazghantsvetmet Association at LME.

The main problem of Kazakhstan enterprises is an acute shortage of concentrates for copper smelters which have become to a large extent dependent upon imported concentrates. At an annual volume of copper mining of 302 kt and a refined copper production capacity of 570 kt, the actual production volume in 1992 was 370 kt.

When being part of the USSR, Kazakhstan had actually no metal export. But during the year 1992 about 220 kt of copper of different marks was shipped abroad (sometimes at reduced prices), 145 kt of copper was shipped to the Ukraine (most of it was then also shipped to Western Europe). This is why steps are taken in the Republic to provide inspection on metals' export by state organisations. In 1993 quota for copper export was set at 120 kt.

The following deposits can be of interest for investors: Boshekulskoye, Aktogayskoye, Koktenkolskoye and Ayardly.

### Armenia

In Armenia there are 9 deposits, 6 of them are major copper deposits. Copper reserves of the Republic make up about 5 per cent of the former USSR's total and the copper production is 2.5 per cent of the total. The main type of deposits are copper-molybdenum ores. There are also massive sulphide ore deposits.

Kajaranskoye deposit of copper-molybdenum ores is one of the largest deposits in mined Armenia.

Until recently, copper-bearing ores were mined and processed by the Agarasky and Zangezursky copper-molybdenum complexes, Kafansky mining and beneficiation complex and Alaverdsky mining and metallurgical complex. Rough and refined copper was produced at Alaverdsky mining and metallurgical complex.

There are no data on copper concentrate or rough copper production in Armenia in 1991-1992. Military operations and a sharp drop in power supplies resulted in a considerable reduction of production volumes at Armenian mining and beneficiation plants. According to private information sources, at present the plants operate periodically.

### Georgia

In Georgia there are 4 known copper deposits. At one of these deposits several types of ore occur. This is the Madneulskoye deposit with reserves of copper, copper-zinc and baryte ores. The Madneulskoye deposit is worked by Madneulsky mining and beneficiation complex. The produced copper concentrate is supplied to the Sredneulsky copper smelter and Alaverdsky mining and metallurgical complex.

### Azerbaijan

In Azerbaijan there are 3 deposits of polymetallic ores, but these are only reserves under exploration and not mined.

### Uzbekistan

Uzbekistan has 12.5 per cent of the copper reserves of the former USSR's territory and produces 7 per cent of the total copper output. There are 6 deposits including 3 major copper deposits.

The estimated reserves of four of the mined deposits correspond to 37 per cent of the total reserves in the Republic of Uzbekistan. Practically all the copper is found in porphyry copper deposits. The targets of these are the Dalneye and Kalmakyrskoye mines.

Ore mining and processing in Uzbekistan is done by Almalyksky mining and metallurgical complex which comprises of 2 beneficiation and 2 metallurgical plants. The produced copper concentrate is supplied to copper smelting plants of Almalyksky complex.

The Dalneye deposit can be of interest for foreign investors.

### Tajikistan

In Tajikistan 12 small deposits were prospected. Copper occurs as an accessory component in complex polymetallic and lead-zinc ores. Copper is not recovered from any of these ores.

The Bolshoy Kanimansur deposit of complex silver-polymetallic copper-bearing ores can be proposed for joint development.

### Summary

Summing up the above information the following main conclusion- can be drawn:

- Russia and Kazakhstan account for the greater part of the copper reserves (82 per cent) and ore production (89 per cent) on the territory of the former USSR;

- The predominant commercial types are copper-nickel sulphide ores, cupreous

sandstone, copper pyrite and copper porphyry ores. The largest deposits are: Udokanskoye, Talnakhskoye, Oktyabrskoye, Gayskoye (Russia), Jezkazghanskoye, Aktogayskoye, Ayardly (Kazakhstan),

- The largest copper mining and processing regions are: Norilsky region, The Urals, Bashkortostan Republic (Russia), Jezkazghan and East-Kazakhstan regions (Kazakhstan);

- The largest CIS enterprises engaged in copper-bearing ore mining and processing are Norilsky Nickel concern, Gaysky and Uchalinsky mining and beneficiation complexes (Russia), Jezkazghantsvetmet and Balkhashmed Associations (Kazakhstan);

- The largest enterprises for refined copper production are Norilsky Nickel concern, Uralelectromed Association (Russia), Jezkazghantsvetmet and Balkhashmed Associations (Kazakhstan),

- The production of copper concentrate and rough copper in 1992 dropped compared to 1991 and 1990 and the refined copper production increased compared to 1991, and is approximately at the level of 1990;

- An increase in the costs of copper mining, processing and smelting results in a rise of copper price in Russia which is now approaching the level of the world price;

- There is evidently a shortage of raw material for the copper smelters in Russia and Kazakhstan. Until recently, this shortage was partially filled by imported concentrates. The problem can be solved through the mining of a number of deposits developed for exploitation. For the development this foreign investments could be attracted. ■

**Note:** Detailed reports on copper reserves and enterprises in the CIS, as well as data on any other metals/minerals in these countries are available from INFOMINE Co. c/o Dr. Mikhail Burstein, Department of Mineral Resources Engineering, The University of Nottingham, University Park, Nottingham, NG7 2RD, U.K.