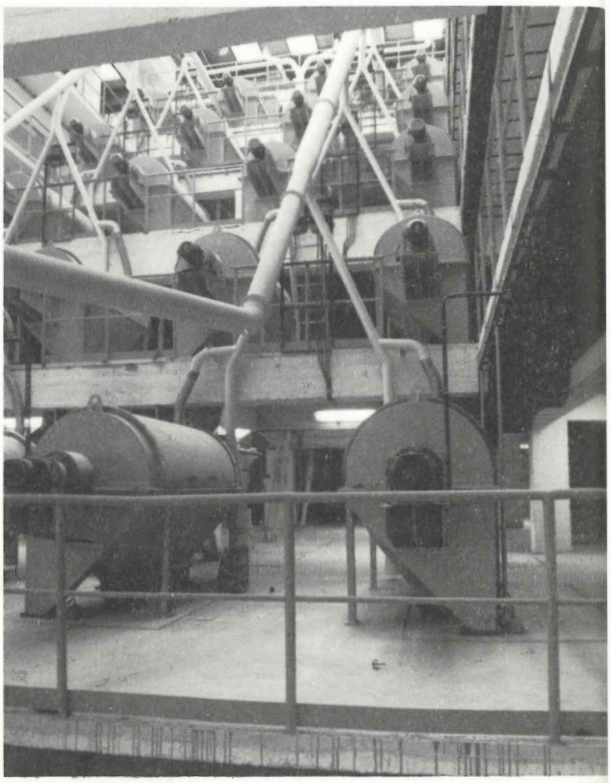
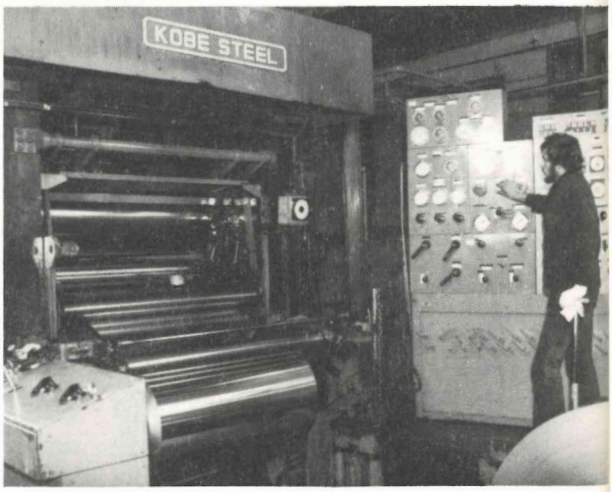
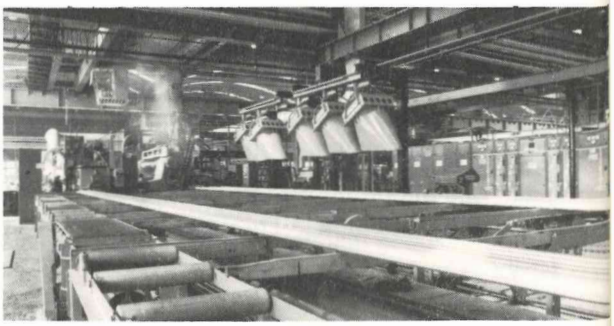
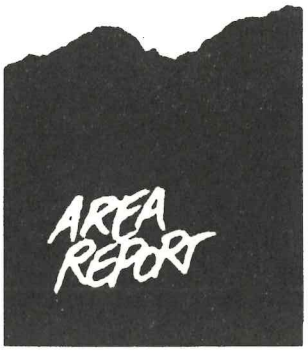
Alumina factory, Ajka (left). Alumina factory, Moson Magyaróvár, classification of corundum grains (top right), Metal working plant, Köbanya, production of foil, cold rolling stand (right middle), Metal working plant, Székesfehérvar, extrusion workshop (right bottom).









Hungary's non-ferrous metal industry – a survey

By György Dobos

Aluminium production plays a key role in the Hungarian non-ferrous metal industry.
György Dobos looks at the history of the aluminium industry and its long term development objectives.

György Dobos has been working for Hungalu and is now retired.
Address:
György Dobos, Kossuth Lajor u.3, 1053 Budapest, HUNGARY.

The article is based on information prepared for the UNIDO Expert Meeting on the Restructuring of the Non-ferrous Metals Industries, held in Vienna, Austria 18-21 March 1985.

Hungary has practically no heavy non-ferrous metal ore resources of its own. Whatever heavy non-ferrous metal is used in this country has either to be imported or to be remelted from collected scrap. On the other hand, Hungary is possessing rich bauxite reserves, on which a fully integrated aluminium industry is now based, operated by the Hungarian Aluminium Corporation.

At this point it may be added that copper and copper alloys are processed on an up-to-date standard to rolled and drawn rods, wires, tubes and strips at the Csepel Works at an annual capacity of 60 kt. The production of lead and zinc semi-manufactures is not significant. As for processing nickel, no official statistical returns are available.

For these reasons the present survey is essentially dealing with Hungary's aluminium industry only.

In Tables 1—4 the country's non-ferrous metal resources, exports, imports and domestic consumption are summed up as shown by 1983 official statistics.

Bauxite operations

The beginning of bauxite prospecting in this country are dating back to the turn of the century, gathering some momentum during the First World War years. From this time onward, mining rights were granted to certain consortiums, eg Aluminium Ore Mining and Industrial Company (AIAG), permitting them to explore and develop such bauxite ore occurrences as appeared to be commercially feasible. It was in 1926 that actual bauxite mining operations were taken up at an opencast site in the vicinity of the township of Gánt.

In the hilly regions of the Vértes and Bakony Mountains such opencast operations were at first carried out manually. Later on, however, in view of rising demand and certain geological considerations, a measure of mechanization had been applied, stepped up in subsequent years, so that by 1935 opencast bauxite quarrying had become fully mechanized.

Underground mining had to be started in the early 1940s when some of the bauxite reserves overlain by heavier strata of overburden were found to be no longer economically accessible by opencast quarrying. At this juncture, at various points, timber-supported inclined shafts were sunk and worked at to operate such sites by means of break-off excavation. In the early 1960s some 80 per cent of the bauxite had to be mined underground and only 20 per cent by opencast operations, applying modern technologies throughout, of which some were up to high international standards, especially as far as cavern water protection and other hydrological aspects, underground transport and haulage, productivity and mechanization, as well as operational and personal safety were concerned.

A clearcut exploration concept was first launched in the 1950s when the Hungarian-Soviet Bauxite and Aluminium Company, then owning these mining sites, had drilled an overall depth of 17.2 kilometres by a total workforce of 134. Exploration was subsequently carried on to reach by 1982 an overall 123.6-kilometre drill-depth mark by employing a total staff of 974.

Today Hungary's bauxite operations are designed to furnish a 2.5 Mt annual quota of ore for use by domestic alumina plants to meet their complete bauxite demand. In addition to this, a volume of 500 kt of lower grade bauxite is set aside each year for export ends. Total annual output is thus in the order of 3 Mt.

The bauxite to alumina export price ratio is 1:6.5, approximating that of general world market trends.

Under the auspices of the Hungarian Aluminium Corporation an exploration and two mining companies are operating. The mining sites are situated in the central Transdanubian area of Hungary at the foot of the Bakony, Vértes and Gerecse Mountains.

While the mining companies are

forming part of and controlled by the Hungarian Aluminium Corporation the actual export deals are transacted on behalf of the Corporation by the *Mineralimpex* foreign trade company;

The bauxite is presently exported to Czechoslovakia, the German Democratic Republic and to Poland. Although bauxite exploration is currently resumed with good prospects, no rise in the present export quota is envisaged.

In bauxite mining and exploration a total workforce of 4 000 is engaged, including personnel operating in auxiliary workshops. Compared to mining sites working under similar geological circumstances abroad, the operations of Hungarian bauxite mines may be considered to be of high standard, supervised and directed by a staff of competent technicians and engineers. At present, one-third of the ore is won by opencast quarrying and two-thirds by underground mining. Circumstances under which the ore is won are difficult. In opencast quarrying an overburden of 7—10 cubic metres has to be stripped off to win one ton of ore; the overall magnitude of such lodes varies from 50 kt to 1 Mt. In underground mining, where 80 per cent of the ore won is located below karstic water level, sizes of lodes are within the 3—20 Mt range.

Notwithstanding the severe conditions referred to, per head productivity of undergrond mining is relatively high, amounting to 5 tons per shift for all hands employed in underground operations, and 24 tons per shift for workers engaged in the actual labour of directly working such deposits, these figures being attributable to a high degree of mechanization. On the debit side, however, there are heavy maintainance and repair costs.

Within a radius of 50 kilometres the ore is transported by road and to farther destinations by rail.

The magnitude of annual bauxite output has now been stabilized for many years past at a 3 Mt level. At the present rate of bauxite consumption by

Table 1

Hungarian production of bauxite, alumina and aluminium 1970—1983
(in kt)

Item	1970	1975	1980	1981	1982	1983
Bauxite	2 022	2 890	2 950	2 914	2 627	2 917
Alumina	441	756	805	792	743	836
Aluminium	66 029	70 221	73 498	74 253	74 221	74 039

Table 2

Hungarian imports of selected minerals and metals
(in kt)

Item	1975	1980	1981	1982	1983
Copper and its semi-manufactures	44 529	28 962	35 799	33 428	31 786
Zinc	26 513	24 329	26 660	19 291	26 904
Zinc products	6 296	7 215	6 927	7 027	5 892
Lead	12 392	12 891	11 033	13 647	11 930
Tin	1 786	1 662	1 369	1 772	2 038
Aluminium ingots[1]	147 000	188 000	154 000	137 000	163 000
Aluminium semi-manufactures	9 916	7 923	5 759	6 262	4 997

Note:

[1]Under the Hungarian—Soviet alumina/aluminium agreement annually 330 kt of alumina are exported to the USSR and 165 kt of aluminium ingots are imported from there to Hungary.

Table 3

Hungarian exports of bauxite, alumina and aluminium
(in t)

Item	1975	1980	1981	1982	1983
Bauxite	603 000	542 000	498 000	467 000	431 000
Alumina	686 000	686 000	626 000	542 000	659 000
Aluminium ingots	60 821	84 216	85 741	48 363	57 822
Aluminium semi-manufactures	46 628	28 861	31 230	42 289	48 479
Aluminium castings	1 985	1 670	1 320	1 312	985
Aluminium scrap	17 627	9 372	8 709	8 740	6 498

Table 4

Hungarian consumption of non-ferrous metals and products (in kt)

Item	1975	1980	1981	1982	1983
Copper products	21.0	22.0	28.0	27.0	27.0
therefrom by industry	20.0	21.0	27.0	26.0	26.0
Brass products	15.0	15.0	16.0	16.0	16.0
therefrom by industry	15.0	15.0	15.0	15.0	15.0
Zinc	25.462	24.974	27.393	26.004	25.699
therefrom by industry	25.343	24.619	27.025	25.560	25.363
Lead	43.939	12.273	11.753	13.653	13.272
therefrom by industry	13.228	10.824	10.869	12.801	10.776
Tin	1.666	1.607	1.647	1.585	1.547
therefrom by industry	1.282	1.092	1.095	1.060	.857
Bauxite	2.277	2.437	2.368	2.238	2.504
therefrom by industry	do	do	do	do	do
Alumina	170	.188	.189	.187	.189
therefrom by industry	do	do	do	do	do
Aluminium ingot, slab and billet;	.166	.166	.168	.177	.182
therefrom by industry	.166	.166	.158	.170	.173
Rolled aluminium strip and sheet	. 62	. 75	. 77	. 77	. 77
therefrom by industry	. 56	. 68	. 70	. 68	. 67
Extruded and drawn aluminium products	. 54	. 56	. 59	. 58	. 54
therefrom by industry	. 51	. 53	. 56	. 54	. 50

Hungary's alumina plants the explored and developed reserves appear to be sufficiently large to provide for such needs well beyond the turn of this century. However, since already operating reserves, too, are tending to deplete, new mining sites have to be continuously explored.

Executives of the Hungarian Aluminium Corporation and the mining companies, as well as such authorities and organs as the National Labour-Safety Inspectorate, the National Mining Inspectorate and the trade unions are regularly checking and supervising whether the valid labour-safety, health and operational safety regulations are strictly adhered to.

Alumina manufacture

The first alumina plant in Hungary was commissioned in 1934 with an annual capacity of 2 kt. During the World War II years capacity had risen to 20 kt per annum. In the immediate post-war years Hungary had two alumina plants: one at Magyaróvár and another at Ajka, operating at a total capacity of 36 kt per annum. In 1951 a third alumina plant of 50 kt annual capacity was put into operation at Almásfüzitö. Production at these three alumina plants has been raised in several successive stages to reach today's 880 kt per annum mark (Ajka 475 kt, Almásfüzitö 330 kt and Magyaróvár 75 kt per annum).

In the pre-war foundation of the Hungarian alumina industry German capital had been participating. After World War II German assets were taken over by the Soviet Union as part of war reparations. In 1955 — under a bilateral agreement — the Soviet Union ceded its share to the Hungarian government.

At present the alumina plants are operating practically at full capacity. More then 20 per cent of output is devoted to domestic ends and about 80 per cent to exports.

Hungarian alumina plants are using medium-grade boehmitic bauxites of a Al_2O_3/SiO_2 ratio of 7—7.5 to be processed to alumina by the Bayer process. The latter is suitably adjusted to allow for certain properties involved in the use of medium-grade bauxites. The technological standard of production may be considered high. In all three alumina plants digesting temperature is 240°C; in one of them a tubular digesting system is installed. Each phase of technology is taken care of by efficient production units forming heavy-duty production lines of suitable automation. Next to metallurgical grade alumina also such to be used in the manufacture of abrasives and refractories, as well as other special brands of alumina, are manufactured.

Per ton alumina performance data for 1984 were averaging as follows: bauxite 2 951 tons, vapour 3 037 tons, caustic soda 0.162 ton; owing to extremely cold weather in the last two months of 1984, the above performance data are slightly higher than those of 1983.

The present price of bauxite purchased by the alumina plants is 780 forints per ton.

Available capacities are fully utilized; possibilities of marketing alumina products are throughout ensured by various long-term agreements.

The cost-effectiveness of operations is such as had been calculated upon the launching of projects.

Profits after tax are in the first place devoted to investments aiming to maintain and improve the standards of available facilities, eg the construction of red mud yards etc, with a fair share appropriated to promote the welfare of workers (social and cultural amenities, financial contributions to housing).

The government is refunding taxes in respect of exports, as provided for by standing fiscal regulations.

The labour force engaged in alumina operations at Ajka is 1 500, at Almásfüzitö 1 130 and at Magyaróvár 690. Productivity is 320 tons per annum and capita at Ajka, 290 tons per annum and capita at Almásfüzitö and 109 tons per annum and capita at Magyaróvár; discrepancies in these figures are due to variations of scale.

The aluminium industry has a Research and Engineering Institute, catering for every stage of vertical integration. Its alumina division used to play an active part in developing domestic alumina plant facilities and adapting suitable technologies, as well as in transferring know-how and engineering to implement various alumina projects abroad. Cases in point are alumina plants at KORBA (India), Tulcea (Rumania), LAUTA (German Democratic Republic) and several others in Jugoslavia.

Manpower at the alumina plants is competent and suitably trained. Some 7 per cent of the total staff are graduates of higher education.

In conjunction with alumina production, Magyaróvár is also a major manufacturer of abrasive grains (22 kt per annum), refractory furnance lining blocks (8 kt per annum), mullite (10 kt per annum) and aluminium sulfate (63 kt per annum). Preparations are also under way to put an annual volume of about 1.5 kt of refractory ramming pastes on the market.

In alumina manufacture some further expansion of the Ajka and Almásfüzitö facilities is now being envisaged. Also efforts are made to raise the output and selection of several well-marketable special alumina brands to be used for different ends.

Labour-safety and health-protecting devices in this field are relatively easy to install. Current technologies are now all designed to comply with this particular demand.

Aluminium smelting

In Hungary the first charge of electrolytically extracted aluminium was tapped 50 years ago at the Csepel Metal Works. Following this, in 1940 the Tatabánya Aluminium Smelter and in 1943 the Ajka Aluminium Smelter financed by both domestic and foreign capital have gone on stream. In 1944 total domestic primary aluminium output amounted to 9.952 kt. In the post-war years a new aluminium smelter has gone into operation at Inota (1952), followed by the addition of a third potline at the Tatabánya Smelter (1959), with the Csepel Smelter, in the meantime, ceasing operations. At present the country's total primary aluminium production amounts to 77 kt per annum.

At the outset, these projects were financed by Hungarian and partly German capital; after the end of hostilities they were taken over by a joint Hungarian—Soviet consortium, and as from 1955 they have been operating and expanding as Hungarian state-owned enterprises. The electrolytic furnaces installed in Hungarian smelters are on the side- and vertical-stub Söderberg anode system originally patented by Elektrokemisk A/S of Norway. In the 1940s it was considered to be the most advanced type of its kind from a furnace design and electrical performance point of view.

On the reconstruction of the potlines most of the heavy labour involved in

Bauxite mining, Iszkaszent György.

manipulating the furnaces has been mechanized and up-to-date silicon-diode rectifiers have been installed to furnish dc current. However, compared to latest advances in this field, the design and operation of these electrolytic furnaces are of a medium standard. Nevertheless, some performance data arrived at by the present facilities are quite remarkable, eg the 15 538 kWh/ton average dc power consumption recorded in 1984.

As for processing the molten metal on site, in due course up-to-date continuous casting technologies were introduced, along with possibilities of a further processing of strip and rod wire won by such technologies. Today 52 per cent of smelter production is sold either in form of continuous cast products, and/or locally reprocessed to semi-fabricated items (strips, slugs and drawn wires).

Present-day facilities are the outcome of a 25-year expansion drive.

In composition meeting the 1 000, 3 000 and 5 000 series of AA standards, rolled products are made from slabs of 3-7-ton weight.

The minimum thickness of rolled products is 0.2 mm and their maximum width 1 500 mm. Plates and sheets may be cut to maximum lengths of 4 000 mm. Under present technologies rolled products are avialable in the soft, quarter-hard, half-hard, three-quarter-hard and hard state. Deep-drawing properties of discs are fully up to demand by the holloware industry. The uniformly even lay of sheet and strip surfaces is further improved by using stretch-dressers.

Foils are made from a 1 235 AA material in up to 1 400 mm maximum width. Their minimum gauge is 9 microns.

Most extruded products are made from materials of the 6 000 AA series. Principal end-users of such items are the building trade, the transport vehicle manufacturing and other industries.

Some 30 per cent of production is exported, meeting the requirements of well known foreign standards.

For this year a production of 180 kt is envisaged. The light metal works employ a workforce of 5 000. Of these 5 per cent are graduates of higher technical education, 13 per cent of medium-grade technical education and 28 per cent are skilled workers.

At present no expansion of available facilities is being implemented.

All bauxite, alumina, smelting and semi-fabricating facilities as described in the foregoing are integrated within the Hungarian Aluminium Corporation.

Exports by the Corporation are significant. Actually, some 47 per cent of the Corporation's present earnings may be accounted for by such exports.

With its more than 20 000 employees, the Hungarian Aluminium Corporation is today one of the foremost industrial concerns of the country.

The total number of workers employed at the smelters is 2 100; of these 17 per cent are engineers, technicians and clericals, and 83 per cent physical workers.

In line with the technological standard of the smelters, working conditions leave a great deal to be desired from an atmospheric pollution and physical labour point of view. Hungarian standards as to fume emission comply with those of their international counterparts, but owing to the circumstances referred to above, cannot at present be complied with.

The Hungarian Aluminium Corporation is now investigating various alternatives of how working conditions on the shop-floor could be improved and how environmental pollution could be reduced. It is considering, amongst others, possibilities of installing new smelting capacities based on the more-up-to-date block-anode system. It is hoped that by such technical development the general standard of Hungarian smelting operations may be raised, along with improvements in working conditions, the environment, and last but not least, in the productivity of labour.

Semi-manufacturing

Using imported metal and a copper rolling mill, the manufacture of semi-fabricated aluminium products began in the mid-1920s; subsequently it was carried on by several independent limited companies. In 1938 production had risen to 1.6 kt.

Following this, several new semi-manufacturing plants have come into being, specialized in aluminium processing. By 1944 annual semi-manufacturing output amounted to 5 kt. In the post-World War II period production has been as follows: 1950 = 12 kt; 1960 = 33 kt; 1970 = 80 kt; 1980 = 150 kt; 1985 = 180 kt (with annual capacities being 200 kt).

The selection of available semi-fabricated products is wide, encompassing the following types of items: rolled plate, sheet, strip and disc; extruded rods, sections, tubes; continuous-cast and drawn wire; forged pieces; a variety of high-finish foils (laminated, painted, printed, etc); anodized products. In domestic orders stipulations as per Hungarian Standard Specifications are called for; such stipulations, are in most cases up to the well known foreign standards. ■