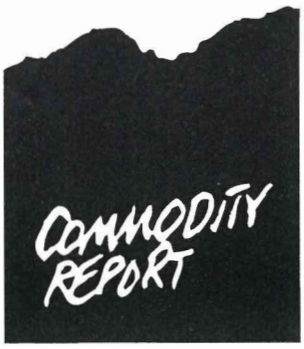

Bauxite supply in a changing market

By Dennis E. Morrisson

This article examines some of the endogenous and industry-specific factors that affect production, supply, demand, costs and prices as they affect bauxite supply. At the outset, however, it will depart from the normal approach and instead, focus on recent international political and economic changes which are likely to profoundly alter some of the fundamental underpinnings of the markets for metals and the world economic system generally.

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The loss of power by communist regimes in Eastern Europe and particularly the demise of the former USSR is rightfully recognized as the most far-reaching development in world affairs since World War II. However, too many Western commentators seem to view this development as merely having implications for the Eastern Europeans themselves without giving due regard to its effect on the economies of the rest of the world. Likewise, our industry's attention is directed mainly to the short-term problem of surplus metal being exported by the CIS countries.

And even here, the industry seemed to have been caught off guard, as it took quite some time to realize that the political changes in the former USSR were having serious economic consequences, one of which is the sharp increase in aluminium exports to Western markets and the depressing effect of this on metal prices. The truth is that the end of the "Cold War" has not only brought profound changes to the medium and long-term process of development of the former USSR and Eastern Bloc countries but to certain areas of Western economies as well.[1] To get some idea of the likely long-term economic changes, let us look at how the "Cold War" impacted on the psychology of economic development in both East and West.

Strategic Considerations

Ever since the October Revolution of 1917 and moreso since World War II and the perceived threat of communist expansion, strategic considerations concerning the physical availability and control of certain metals with military and economic importance were determining factors in the location of production capacities in both camps more so than in earlier periods. These considerations also influenced trade generally and were superimposed on the normal economic criteria of efficiency, comparative advantage and market-driven production. In recent years, even before the break up of the Eastern Bloc, the role of strategic military considerations in Western economies had somewhat diminished in terms of some metals including aluminium[2] and in fact the US Strategic Stockpile of bauxite is now being disposed of.

Nonetheless the psychology of economic security was still a major factor in the West in determining the location of production capacity for various metals and was also the driving force to continuously explore for and develop new sources of raw materials including bauxite, in circumstances where vast reserves were already proven and available.[3] Of course, economic security and strategic considerations derived not just from the East-West conflict but also involved the perceived threat of nationalization of raw materials sources by governments in developing countries – this threat itself also being linked to communist expansionism.[4]

In countries of the former Eastern Bloc, strategic considerations continued to be decisive in decision-making and were largely responsible for the autarchic approach to economic development. In addition, the restrictions placed by Western governments on tradable goods and services were reinforcing factors.

Hence, in economic terms, the broad results of the East-West conflict can be identified as follows:

1. Severe restrictions on trade and economic exchange with a market of almost 400 million persons at income levels substantially above middle-income developing countries.

2. Relatively limited access of the West to vast reserves of oil and gas, iron ore, nickel and a range of precious metals.

3. Sub-optimal allocation of resources in several metals industries in the West and in the East.

4. The heavy outlays on military hardware.

Whilst the end of the "Cold War" will not erase all geopolitical considerations in investment decisions, economic considerations are likely to predominate which will mean not only immediate but also far-reaching changes in the medium and long-term economic landscape of the world and Europe in particular.

The short-term consequences of the changed world political climate are already discernible most notably in the dislocations being felt in Eastern Europe especially on the economic scene. These dislocations are of course, affecting some areas of Western economies such as the aluminium industry and have also severely depressed the usual level of trade between East and West.[5]

Hence, it is understandable that there is some preoccupation with the immediate negative picture. However, assuming that the changes are by and large irreversible, which might not be generally agreed at this time, then greater attention must be increasingly given to the medium and long-term economic prospects and the mechanisms for realizing the positives and minimizing the negatives.

Economics to Play Greater Role?

Since the end of World War II, the locus of the Western world's primary aluminium industry has evolved from total concentration in Western Europe and North America to include Latin America, Australia, India and the Middle East.[6] This shift was driven by:

1. The demand for greater raw material supply to meet the rapid growth in the consumption of aluminium at the same time as the bauxite reserves of the original regions were being depleted.

2. The strategic considerations of diversifying supply sources to, among other things, minimize risks associated with nationalization or social instability.

3. The move to tap cheaper energy sources outside of North America and Europe since the first oil shock of 1973.

Significant investments in the 1970's were undertaken on economic grounds: the massive expansion of alumina capacity in Australia (from 6.0 Mt in 1975 to 11.7 million in 1990), new bauxite mines in Brazil and new smelters in Brazil, Venezuela and the Middle East.

However, new investments were also undertaken in alumina refineries in Western Europe (Spain, Italy, Ireland) necessitating the haulage of bauxite from far-flung producing countries.

New smelter capacity was added in Spain (San Cipriano, 1978), USA (Alumax, Mt. Holly, 1980) and France (Dunkirk, 1992) although these areas showed no comparative advantage in energy or raw material costs. More important than the new investments in refineries and smelters in areas not endowed with cheap energy or bauxite resources, has been the continuation of alumina and aluminium production at locations in North America and Europe where production costs are significantly out of line with the economically efficient producers. No doubt, the shortage of replacement capital, rigidities associated with social legislation in some areas, as well as subsidies of one kind or another influenced the decisions to keep these plants in operation.

It is perhaps also the case that some inertia in the psychology of military-economic security persists and dictates that companies strategically locate their plants to minimize perceived political and economic risks.

As indicated earlier, the end of the "Cold War" and the reversal of the "nationalist" outlook of raw materials producing developing countries should significantly reduce the political risks of nationalization.[7] Furthermore, the policy shifts which have taken place in several developing countries in favour of foreign private capital: deregulation, privatization and trade liberalization, point to an investment climate which could lead to a more rational international division of labour. In such a scenario, one can anticipate that the activities of the aluminium industry as well as others will be organised on the basis of greater reliance on economic criteria of production costs, efficiency and comparative advantage with lessening importance being attached to other considerations. For the aluminium industry, this implies that the location of bauxite and alumina production should be determined by the relative costs of bauxite and energy, transportation costs, environmental considerations, relative capital costs of new capacity (which are dependent on infrastructure, and industrial capacity) and the availability of skilled manpower.

Table 1
Selected non-bauxite alumina plants in CIS countries 1990

Location	Capacity (t)	Raw material source
Achinsk, Siberia	900 000	Nepheline
Pikalevo	200 000	Nepheline
Sumgait, Azerbaijan	150 000	Nepheline
Volkhol	150 000	Nepheline
Total	1 400 000	

Sources: JBI, Aluminum, Alumina and Bauxite, 1991, Yearbook by AME Mineral Economics, Australia

Eastern Europe: End of Autarchy?

The aluminium industry of this region is, to a large extent, organized on the basis of maximum internal production of raw materials. It is no secret that in many instances this approach resulted in the uneconomic production of bauxite, alumina and aluminium. The use of outdated technology is yet another factor which characterizes alumina and aluminium production. Thus, the rejection of autarchic development could mean greater scope for rationalization of the industry on economic grounds.[8]

In the former USSR, the industry is favoured by an abundance of energy sources, a potentially large market for metal and sizeable smelter capacity capable of modernization. It is, of course, hindered by poor environmental practices, tremendous over-manning, bauxite and non-bauxitic aluminous raw materials with high extraction costs (nepheline, alunite) now severely compounded by capital shortage.

The pace of the transition to a more efficient production system will be dependent on:

1. The ability to manage the dislocations which will result from the closure of uneconomic smelters and alumina plants.
2. The availability of capital (a large portion of which must be raised externally) in the tight domestic economic circumstances and weak international economic environment.
3. The price of metal which must be high enough to recover the investments etc.

Rationalization of production will impact most heavily on the mining and alumina sub-sectors of the industry. Present alumina production based on alunite and nepheline is uncompetitive and highly inefficient. Of the present effective alumina capacity of approximately 5.3 Mt over 2.3 Mt (See Table 1 for known non-bauxitic plants) are based on these raw materials. Thus, over 40 per cent of the alumina supplied from non-bauxitic sources will probably be displaced before plants being supplied by domestic bauxite sources are considered.

The picture for the rest of Eastern Europe is not very different as the five refineries producing metal grade alumina are also operating on expensive domestic and imported bauxite. Closure or conversion of these facilities over the medium-term would remove approximately another 1.4 Mt per annum of refinery capacity from metal grade alumina production.

Hence, the region as a whole would require at least an additional 3.0 Mt per

Table 2
Top six Western bauxite producing countries 1950–1990

	1950	% of top 6 production	1960	% of top 6 production	1970	% of top 6 production	1980	% of top 6 production	1990	% of top 6 production
1.	Suriname	32.3	Jamaica	33.8	Jamaica	32.2	Australia	41.6	Australia	47.4
2.	Guyana	24.9	Suriname	20.0	Australia	24.9	Guinea	21.3	Guinea	19.8
3.	USA	21.0	Guyana	14.5	Suriname	16.2	Jamaica	18.4	Jamaica	12.5
4.	France	12.5	France	12.0	Guyana	11.9	Suriname	7.5	Brazil	9.7
5.	Indonesia	6.1	USA	11.7	France	8.2	Brazil	6.4	India	6.0
6.	Yugoslavia	3.1	Guinea	8.0	Guinea	6.7	Yugosalvia	4.8	Suriname	3.7
Total prod. of top 6		6 448		17 278		37 246		65 261		87 335
World prod.		6 847		22 492		50 812		82 244		101 209
Top 6, % of world prod.		94.2		76.8		73.3		79.4		86.3

Source: World Metal Statistics

Table 3
World bauxite reserves (Mt)

Guinea	5 600
Australia	4 440
Brazil	2 250
Jamaica	2 000
India	1 000
Indonesia	750
Guyana	700
Cameroon	680
Greece	600
Suriname	575
Ghana	450
Yugoslavia	350
USSR	300
Hungary	300
Venezuela	235
People's Republic of China	150
Sierra Leone	140

Source: US Geological Survey, Professional Paper 1076-B/Sam Pattersson et al.

Table 4
Buaxite Exports of top six western world production (kt)

	1950	1960	1970	1980	1990
Total exports	4 102	10 471	18 702	28 717	30 711
Total production	6 488	17 278	37 246	65 261	87 335
Export as % of prod.	63.2	60.6	50.2	44.0	35.2

Sources: JBI, World Metal Statistics, Various reports.

annum of imported alumina or roughly 8 per cent of present Western world production.

Recent Trends in Bauxite Supply

Bauxite Production

Over the last 40 years, the geography of the Western world's bauxite production has shown significant change. In 1950, the top six producing countries (See Table 2) accounted for 94.2 per cent of total production, by 1960 this had declined to 76.8 per cent, by 1970 to 73.3 per cent before rising to 79.4 per cent in 1980 and further rising to 86.3 per cent in 1990. During this period, the countries comprising this list also changed. Only Suriname, which occupied the first spot in 1950, remained among the top six producers in 1990. The USA and France, both major players in the 1950's have disappeared from the geography of bauxite production while India is now emerging as a potentially powerful player. Jamaica has remained among the top three producers for over thirty-five years while Australia's production now exceeds the combined total of Guinea, Jamaica and Brazil. While expansion and the earlier mentioned strategic considerations allowed the diversification and deconcentration of capacity, reconcentration has been occurring since the mid-seventies due to economic considerations.

This development reflects primarily the location and availability of bauxite reserves (See Table 3) and the relative costs of mining and in situ processing of the various bauxites.[9]

It is also important to note that whereas bauxite processing facilities were concentrated in North America and Western Europe in 1950 thereby necessitating the export of over 66 per cent of the bauxite production of the top six producers, by 1990 this was reduced to 35 per cent. (See Table 4). Two of the top six producers still remain large exporters of bauxite (Guinea and Brazil) whereas Australia and Jamaica have significantly reduced the ratio of exports to total production. It is expected that the completion of the Alunorte refinery in Bazil will also appreciably reduce that country's bauxite exports.

The two main trends apparent in the bauxite sub-sector are therefore: (a) concentration of production in few countries with clear comparative advantage; and (b) greater reliance on in situ processing.[10] It is hard to envisage a refinery being built today in an area without bauxite.

Alumina Production

The foregoing implies that significant shifts have also occurred in the location of alumina production facilities in the last twenty-five years. In 1966 the top six producers accounted for 79.3 per cent of total Western production, slipping to 76.8 per cent in 1970 and further declining to 71.4 per cent in 1980 and 69.9 per cent in 1990. Australia, which was not among the group in 1966, (with production of only 307 000 tonnes and ranking only 9th), replaced the USA by 1980. The USA, Jamaica and Suriname have survived as top producers while Brazil, Venezuela and India are emerging as major players.[11] The reconcentration which we have earlier seen developed in bauxite will also become manifest as the industry responds to the new world environment.

As in the case of bauxite, the shifts in the locus of alumina production have been driven largely by economic factors, namely: bauxite reserves and energy costs.

The most dramatic shifts in metal grade alumina production have been:

1. The absolute and relative decline in the USA from 45.3 per cent of the top six producers' output in 1970 to only 22.5 per cent in 1990.

2. Australia's even more rapid climb from 16.1 per cent in 1970 to 46.6 per cent in 1990.

3. The demise of Japan, Canada and Germany.

4. The emergence of Brazil, Venezuela and India (3.9 per cent) as important players.

Jamaica has maintained its third position for over twenty years which is consistent with its standing as a bauxite producer.

Australia's rise reflects that country's combination of abundant bauxite reserves and sizeable energy resources (coal, gas) thus making it a low-cost producer.

The size of its bauxite mines (See Table 6) and alumina plants also guarantee significant economies of scale and as pointed out earlier, it was also perceived as a strategically safe place for Western investment and dependence for raw materials. Its proximity to Japan and the broader Asian market were also important.

Brazil and Venezuela's rise also rests on their bauxite resources and competitive labour costs and in the case of Venezuela on its strong energy position as well.

India's emergence is based on the combination of: bauxite reserves (fifth largest in the world), energy resources (coal), highly competitive labour rates and the industrial capacity to produce capital goods at competitive rates and thus provide potentially attractive capital costs. Its proximity to the rapidly growing Middle East smelting area is also promising.

Jamaica's continued high ranking is due to its cheap mining costs, low labour costs and proximity to the North American market.

The demise of Japan and Germany reflects primarily the high energy costs of these countries and the uncompetitiveness of transporting bauxite over long distances. The decline of the relative share of production in Canada is due to the high cost of importing bauxite and expensive labour. The increasingly onerous environmental regulations have been important considerations in all three countries.

The major decline of the USA as an alumina producer, of course, reflects the combination of depleted bauxite reserves, high energy costs, uncompetitiveness of importing bauxite, environmental regulations, expensive labour and other costs as well as the country's reduced demand for alumina consequent on the fall in metal production of 13 per cent between 1980 and 1990. Alumina production declined by 22.8 per cent in the same period and imports also fell by 7 per cent.

It should be observed that the declining contribution of the former major alumina producers in North America and Western Europe to total Western World alumina production coincides with the reduced exports of bauxite by the major bauxite producing countries.

Certainly, greater alumina production in the major bauxite producing countries in Oceania, Latin America and the Caribbean has replaced bauxite exports to these areas.

Table 5
Top six Western alumina producing countries 1950–1990

	1966 % of top 6 production		1970 % of top 6 production		1980 % of top 6 production		1990 % of top 6 production	
1.	USA	58.2	USA	45.3	Australia	34.5	Australia	46.6
2.	Canada	9.9	Australia	16.1	USA	33.6	USA	22.5
3.	France	9.3	Jamaica	12.9	Jamaica	11.4	Jamica	11.9
4.	Jamaica	8.8	Japan	9.6	Germany	7.1	Brazil	6.9
5.	Japan	7.3	Canada	8.3	Suriname	6.9	Suriname	6.3
6.	Germany	5.5	Suriname	7.8	Canada	5.7	Venezuela	5.3
Total prod. of top 6		9 124		13 348		20 922		24 199
World prod.		11 510		17 382		29 304		34 503
Top 6, % of world prod.		79.3		76.8		71.4		69.9

Source: World Metal Statistics

Table 6
Major Western world bauxite mines (Mt)

Name	Country	Capacity
Boke	Guinea	13.0
Weipa	Australia	11.0
Trombetas	Brazil	8.5
Worsley	Australia	7.0
Gove	Australia	6.0
Jarrahdale	Australia	5.0
Del Park	Australia	4.5
Huntley	Australia	4.0

Source: JBI.

This process, however, is not yet complete as 3.68 Mt of high cost metal grade alumina capacity in Western Europe: France (310 kt), Germany (640 kt), Italy (770 kt), Spain (960 kt), Ireland (1 000 kt) remain in operation. In North America, 4.8 Mt of metal grade capacity in four plants is in full operation. As in Western Europe, these plants are being supplied by imported bauxite at higher cost than plants elsewhere which are processing in situ bauxite. In addition, the higher labour and energy costs as well as the cost of environmental regulations (by comparison with Australia, Jamaica, India) mean that the North American and Western European plants are now at the high end of the cost curve. In fact, available unpublished data indicates that the cost differential between Australian and Western European plants are in the region of 40 per cent, while North American plants are about 35-45 per cent. The Caribbean and Latin American plants enjoy a 30-35 per cent differential and is increasing due to recent massive currency devaluations among other factors.

Future Prospects

The future rate of growth in Western World production of bauxite will depend on five main factors, namely:

1. The rate of world economic growth which is the driving force determining the demand for aluminium and alumina.
2. The competitiveness of aluminium vis-a-vis other metals such as steel and copper and other materials such as wood and plastics.
3. The results of efforts to increase the recycling of aluminium products.
4. The intensity of metal use per unit of finished product.
5. Pace of rationalization of the bauxite and alumina sector in Russia and Eastern Europe.

Bauxite Supply Requirements

If it is assumed that the present economic difficulties in major Western economies are short-term, we can expect the growth in metal demand to be in the order of 2 per cent per annum in the medium-term (1993-1997). On this basis the annual supply of metal would have to increase by about 2 Mt, alumina by 4 million and bauxite by 10 million over the period. The rationalization of the CIS aluminium industry in terms of reduced production of alumina from non-bauxitic sources as outlined earlier could generate demand for up to 1.4 Mt of metal grade alumina and roughly 4 Mt of bauxite. Of course, the closure of existing bauxite mining operations and the associated alumina plants in the other Eastern European countries (Hungary and Romania) would add a further 1.5 Mt of alumina and 4 Mt of bauxite to the demand from Western sources.

The overall requirement for additional bauxite and alumina production by Western producers would therefore reach 18 million and 7 Mt respectively by the late 1990's. It should be noted that these projections do not take account of the devastating civil war in the former Yugoslavia which has already resulted in long-term damage to its aluminium industry.[12]

Table 7
Western world alumina capacity expansions/new plants 1992-1997 (kt)

Country/ Company	Expansions 1992–1997
Jamaica	
Alpart	800
Jamalco	200
Subtotal	**1 000**
Brazil	
Alumar	100
Sorocaba	200
Alunorte*	1 100
Subtotal	**1 400**
Venezuela	
Inter-Alumina	400
Subtotal	**400**
Australia	
Gove	200
Wagerup	360
Subtotal	**560**
GRAND TOTAL	**3 360**

Note: * New plant
Source: JBI.

New Capacity Location : Alumina

The advent of incremental expansion of existing alumina plants has been an important factor in reducing the demand for new

plants in recent years. In fact, the last three greenfield refineries were completed in 1983 (Worsley, Alumar and Aughinish). It is estimated that 3-4 Mt of additional refinery capacity have come on stream since the late 1980's via brownfield expansions.

Taking into account the already announced or ongoing expansions (See Table VII) it is estimated that additional alumina output of 3.36 Mt will be on stream by the late 1990's. This leaves a gap of four Mt excluding any fall out from the former Yugoslavia. Assuming that economic considerations predominate as advocated earlier, one would expect that this gap would be filled by new capacity and continued brownfield expansions in the countries with comparative advantage. Australia, Jamaica, India, and Brazil are the leading contenders and already pre-feasibility studies have been completed for several new plants in the first three.

Location of New Capacity: Bauxite

Bauxite supply for the alumina expansions listed in Table 7 will be available at site and will therefore mean increased concentration of bauxite production in the top producing countries and further decline in the ratio of bauxite exported to total production.

Location of the additional 4 Mt of alumina capacity required, is expected to be concentrated in the countries listed and therefore also lead to further concentration of bauxite production. Of the top six bauxite producers, Guinea is likely to lose market share as a result of the movement towards in situ processing of bauxite and its lack of physical infrastructure.

Medium-term closures of uncompetitive alumina plants and smelters in North America and Western Europe are likely to reinforce this trend enhancing the relative position of Australia, Jamaica, Brazil, India and possibly Venezuela.

The lack of consistent and ongoing rationalization in all sectors has been a chronic shortcoming of the world aluminium industry with a high cost being paid by industry players and the consuming public.

The recent profound changes in Eastern Europe have given a fillip to the need to carry this process forward.

The question remains, Is the industry prepared to face the challenge?

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