FERRO-ALLOYS IN A GLOBAL CONTEXT. AN ECONOMIC VIEW OF THE FUTURE

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ABSTRACT

The ferrous metals industry is passing through a most important phase in its development, with all sectors, from the raw material supplier to the end user of steel, finding the need to adapt to an age of high technological development.

The call is for quality which, in effect, requires that stricter specifications and lower levels of contamination be achieved. Consistency, quality, and reliability of raw material supply are becoming increasingly important. Producers of ore, ferro-alloys and steel thus face a new challenge which, in an oversupplied market for most commodities, must be met by those who wish to prosper in the future.

While growth in ferro-alloy production will essentially be concentrated at sources of raw material and plentiful low cost electric power, new steel plants will continue to be installed in countries with developing industrial economies.

INTRODUCTION

The rapid evolution of new techniques in ferro-alloy and steel production that is currently taking place, highlights the awareness, on the part of producers, that the formula for success is closely linked to remaining in the forefront of pyrometallurgical developments. It is certain that never before has so much manpower and money been devoted to research in this field.

This technological revolution, as it might be called, is in no small measure attributable to the increasingly stringent demands of the end-consumer. A further contributing factor is the glut of mineral commodities that has persisted through this decade and that threatens to become a feature of commodity markets for many years to come. This has raised the bargaining power of the consumer and enabled him to become more and more choosy about the quality of his raw materials thus leaving the supplier with little alternative but to pander to his needs. Trace impurities, of which the industry hitherto was unaware, are creeping into specifications when, in some cases, satisfactory analytical techniques are not even available for their determination.

The successful raw material suppliers of the future will emerge as those who show a genuine sensitivity to the particular needs of each consumer, whether it be the alloy producer, steelmaker or end user - inevitably it is the lastnamed that will call the tune.

RAW MATERIAL SUPPLY

Iron, manganese, silicon and carbon are essential to the production of steel and are always present in greater or lesser amounts. Chromium, nickel, vanadium, molybdenum, tungsten, niobium, titanium, rare earths, calcium and magnesium are important to many steels as alloying constituents and/or to the manufacturing process (Table 1).

Few countries do not possess deposits of silica of adequate purity to produce ferrosilicon and major steelmaking countries produce at least a part of their requirements. Economically exploitable resources of iron and carbon (coal, wood, oil or gas) are widespread, although most large western steel-producing countries are deficient in these commodities, with the result that they are amongst the largest bulk tonnage items involved in world trade. Manganese, chromium, nickel, molybdenum, vanadium, niobium, tungsten, titanium and the rare earths are limited in their geographical distribution and hence the number of countries in which they are produced - most western steelmakers are thus dependent on imports. In fact, the USSR, China and Brazil are the only steel giants which are substantially self-sufficient in raw materials.

It may be of little consequence to a steelmaker, however, that a particular country produces large amounts of the raw materials he requires, if these are largely or ex-

TABLE 1 - Alloy Elements added to Steel

Element	Functional Characteristics
Aluminium	Control of grain size and deoxidation
Chromium	Corrosion resistance, high-temperature strength and hardenability
Cobalt	High temperature toughness and hardness
Columbium	As - rolled strength
Copper	Corrosion resistance
Lead	Machinability
Manganese	Deoxidation, sulphur removal, hardenability
Molybdenum	Hardenability, high-temperature hardness, temper brittleness control
Nickel	Surface appearance, low-temperature toughness, hardenability
Rare Earths	Toughness, ductility, impurity control
Silicon	Deoxidation, electrical properties
Sulphur	Machinability
Tungsten	Hardenability and high-temperature hardness
Vanadium	High temperature hardness, grain size control, strength, toughness

clusively consumed by the producing country for its internal needs. For example, the USA and USSR are not only the World's largest producers of mineral commodities, they are also the largest consumers and hence their trade in these materials is relatively minor. As an exporter of ferrous metals, the USA features only in molybdenum and the rare earths. The USSR was historically a substantial supplier of chrome, manganese and iron ore to western markets. In recent years these materials have been supplied in significant quantities only to countries within the Começon Bloc. Hence the fact that Russia is probably the largest producer of ferrous metals is unimportant to the resource-starved western steel producer.

It is, therefore, not surprising that raw material procurement has become a prime concern of the industrialised nations, which has, in turn, translated to a deep concern about the wellbeing of mineral exporting nations. Foremost in their mind are such factors as price, reliability of supply and, especially today, consistency and quality.

They have an inherent deep interest in the stability, political association and international affiliations of countries from which the vital supply chains of raw materials originate. In their endeavours to secure their long term requirements, diversity of supply has become a priority; huge capital expenditure has been committed to mining and infrastructural projects in developing countries from which raw materials originate. Some countries have, as a consequence, used their mineral resources as a bargaining point in the international political arena to obtain loan capital to develop mineral projects.

Iron Ore

As the major raw material used in steel, iron ore has become the single largest bulk tonnage commodity traded on world markets. Iron ore is mined in more countries than any other ferrous commodity and no less than eleven export more than 5 million tons annually (Table 2). In recent years, however, Brazil and Australia have increasingly moved towards market domination, supplying between them some 54 per cent of Western exports in 1984, while the market share of most other suppliers has progressively declined. As will be observed from Table 3, eight of the fourteen largest consumers of iron ore import most of their requirements. Russian exports are mostly destined for markets in the Comecon countries, and both China and the USA, although major producers, import a portion of the iron ore they consume.

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TABLE 2 IRON ORE

World Reserves, Production, Capacity, Exports 1984 (1,2)

(Estimated Iron Content)

COUNTRY	RESERVES		PRODUCTION				EXPORTS		
	$tx10^9$	%	$tx10^6$	%	Rank	Capa-city	$tx10^6$	%	Rank
USSR	22,7	25,4	135,9	28,6	1	165,1	2,3	1,0	11
Australia	18,3	20,5	57,4	12,1	3	79,4	54,5	23,9	2
Brazil	9,8	11,0	62,1	13,1	2	91,6	61,4	27,0	1
Canada	8,9	10,0	25,5	5,4	7	41,7	19,3	8,5	3
South Africa	6,0	6,7	15,4	3,2	8	22,7	7,6	3,3	7
USA	5,4	6,0	31,3	6,6	5	58,1	3,1	1,4	10
India	4,4	4,9	26,4	5,5	6	31,7	15,1	6,6	4
China	3,2	3,6	43,1	9,1	4	38,1	0	-	-
Sweden	2,2	2,5	11,2	2,4	10	12,7	10,9	4,8	6
Liberia	1,6	1,8	11,4	2,4	9	13,6	11,3	5,0	5
Venezuela	1,1	1,2	7,9	1,7	11	15,4	5,2	2,3	9
Mauritania	0,1	-	5,9	1,2	12	6,0	6,2	2,7	8
Other	5,6	6,3	42,2	8,9	-	63,5	30,7	13,5	-
Total	89,3	100	475,7	100		639,6	227,6	100	

The large market share achieved by Australia and Brazil is surprising in view of the substantial excess production which has overshadowed markets for some years and the trend on the part of importers to diversify sources of supply. With slow growth predicted for overall steel production, iron ore capacity utilization is unlikely to exceed 70 per cent for several years at least.

Iron ore production in Western European countries and the USA faces an inevitable decline over the years ahead. As this occurs, producers may well see themselves in the same position as the Japanese and make sure they are not too dependent upon supplies from only two countries - this should provide the opportunity for the other exporters to regain their market share.

Freight rates remain depressed, and the longer the haul the more depressed do the rates become. As a result the transportation cost difference between a Swedish or South African ore into Rotterdam is not all that substantial. It is unlikely that this represents the realities of shipping costs so that any return to normality will benefit the nearby supplier.

Prompted by economic factors and the changing consumer demand, the steelmaker is under constant pressure to implement the latest technological trends, improve quality and increase efficiency. These developments must reflect back to the iron ore producer. There is thus a market opportunity for those producers who endeavour to understand and meet the quality requirements of their customers.

TABLE 3 IRON ORE

Apparent Consumption - 1984 [1]

(Estimated Iron Content)

COUNTRY	CONSUMPTION	WORLD
	$tx10^6$	%
USSR	116,8	25,6
Japan *	76,7	16,8
China	45,3	9,9
USA	38,8	8,5
Germany *	25,1	5,5
France *	12,8	2,8
Italy *	11,5	2,5
India	11,4	2,5
Poland *	9,4	2,1
Canada	9,3	2,0
Romania *	9,2	2,0
UK *	8,7	1,9
Benelux *	8,7	1,9
South Africa	7,9	1,7
Other	64,8	14,2
Total	456,4	100

* Countries which import most of their requirements

Chrome Ore

Chrome ore reserves are concentrated in Southern Africa with relatively small pockets occurring in several other countries (Table 4). In Southern Africa the only deposits capable of meeting world re-

TABLE 4 **CHROME ORE**

World Reserves, Production and Exports - 1984 [1,3]

COUNTRY	RESERVES		PRODUCTION			EXPORTS		
	$tx10^6$	%	$tx10^3$	%	Rank	$tx10^3$	%	Rank
RSA	2 400	55,4	3 340	34,1	1	1 097	28,1	1
Bophuthatswana	800	18,5	347	3,5	8	325	8,3	5
Zimbabwe	753	17,4	477	4,9	5	0		
USSR	129	3,0	2 520	25,7	2	442	11,3	3
Turkey	73	1,7	487	5,0	4	440	11,3	3
India	60	1,4	435	4,4	7	80	2,1	10
Finland	29	0,7	446	4,5	6	273	7,0	6
Philippines	29	0,7	257	2,6	10	244	6,3	7
Albania	20	0,5	905	9,2	3	753	19,3	2
Brazil	9	0,2	300	3,1	9	0		
New Caledonia	8	0,2	84	0,9	11	95	2,4	9
Madagascar	5		60	0,6	12	108	2,8	8
Greece	3	0,1	50	0,5	13	0		
Other	11	0,3	84	0,9	-	43	1,1	
Total	4 329	100	9 792	100		3 900	100	

quirements are those of the Bushveld Complex; the podiform deposits of Zimbabwe have severe reserve constraints and the bulk of the seams in the stratiform occurrences of the Great Dyke are far too widely spaced and narrow to support a viable export industry. Unless the reserves of most of the existing suppliers of chrome ore to Western markets are grossly understated, these countries will find difficulty in maintaining production levels far into the next century. Already, the much sought after plus 3,5 to 1 chromium-to-iron ratio ores are becoming a rarity.

With universal acceptance of AOD technology for stainless steel production, the importance of the high chromium-to-iron ratio ores has diminished. This trend is likely to be further accentuated as production trends move towards techniques such as plasma-arc technology and the production of chrome alloy steels through direct reduction of the raw material. This eliminates a major step in the production process and reduces the need for ferrochromium.

Meanwhile ferrochromium production facilities have migrated from the industrialised nations to countries with chrome ore resources - Japan, Sweden and China are likely to remain the only major importers of metallurgical ore for some years (Table 5). With the use of the AOD process reported to be in its infancy in China, this country is perhaps alone in being dependent upon large tonnages of the higher grade ores.

As will be observed from Table 5, some 75 per cent of ferrochromium trade originated in Southern Africa with the Republic of South Africa supplying the bulk of the World's high-carbon low-chromium varieties. The choice open to the high carbon ferrochromium producers is between the plus 2,5 to 1 chromium-to-iron ratio ores typically supplied by Albania, Turkey and the Philippines, and the 1,5 to 1 ratio ores of South Africa - price is an important determining factor in the final selection.

TABLE 5 **FERROCHROMIUM**

World Production and Exports - 1984 [3,4]

COUNTRY	PRODUCTION			EXPORTS		
	$tx10^3$	%	Rank	$tx10^3$	%	Rank
South Africa	912	31,9	1	863	63,2	1
USSR	432	15,1	2	22	1,6	6
Japan *	324	11,3	3	0		
Zimbabwe	220	7,7	4	200	14,6	2
Sweden *	145	5,1	5	98	7,2	3
Brazil	132	4,6	6	54	4,0	4
China *	120	4,2	7	0		
Yugoslavia *	87	3,0	8	5	0,4	9
Germany *	70	2,4	9	0		
Finland	59	2,1	10	8	0,6	8
Italy *	50	1,7	11	20	1,5	7
Philippines	50	1,7	11	50	3,7	5
Other	260	9,1		46	3,4	
Total	2 861	100		1 366	100	

* Import all or part of chrome ore requirements

The short term scenario thus predicts a continued decline in metallurgical ore trade with ferrochromium taking its place. In the medium term, if current technological advances take hold, chrome ore could regain its market share at the cost of ferrochromium. In the long term, supplies of both ore and alloy, whichever should be in demand, will originate increasingly from South Africa.

Manganese

As is the case with chromium, the large reserve concentrations of manganese ore are located in South Africa, but with substantial amounts also present in Gabon, Australia, Brazil, Mexico, India, the USSR and probably China. The high-grade ore deposits in India and the USSR are largely depleted, however, and the Comecon countries are becoming increasingly larger importers of quality ores from the West (Table 6). There are, however, few steel producing countries which do not possess

TABLE 6 **MANGANESE ORE**

World Reserves, Production, Exports - 1984 [2,3,4]

(Estimated Manganese Content)

COUNTRY		RESERVES		PRODUCTION			EXPORTS		
		$tx10^6$	%	$tx10^3$	%	Rank	$tx10^3$	%	Rank
South Africa	45	5 715	81,7	1 372	16,2	2	1 367	36,9	1
USSR	30	681	9,7	3 026	35,7	1	0 *		
Gabon	50	200	2,9	1 052	12,4	3	2 050	28,4	2
Australia	48	189	2,7	824	9,7	5	701	18,9	3
Brazil	45	73	1,0	990	11,7	4	396	10,7	4
India	35	38	0,5	385	4,5	7	5	0,1	7
Mexico	36	36	0,5	181	2,1	8	50	1,4	6
China	30	30	0,4	480	5,7	6	4	0,1	7
Ghana	40	8	0,1	107	1,3	9	95	2,6	5
Other	35	24	0,3	66	0,8		34	0,9	
Total		6 994	100	8 483	100		3 702	100	

* Imports ore from the West

their own ferromanganese smelters and, with so few suppliers of the raw material, manganese trade is predominantly in the form of the ore. Out of a total Western production (USSR excluded) of 12,6 million tons, no less than 63 per cent is exported with a further 10 per cent being converted to alloys for export. Manganese ore trade totals 8 million tons against only 1,4 million tons (22 per cent of production) for the alloys.

South Africa, Gabon and Australia have dominated ore trade for many years and accounted for no less than 83 per cent of total exports in 1984. Brazil is, however, expected to become an increasingly large exporter in years to come. World ore reserves are adequate for many centuries and surplus production capacity exists in the major producing countries.

The only substantial ferromanganese producers which use domestic sources of ore are South Africa, Brazil, India, USSR and China (Table 7). Norway and France are somewhat unusual as large exporters of ferromanganese, but possessing no domestic supplies of ore and consuming relatively minor amounts of the alloy themselves. In fact South Africa, Norway and France together account for 78 per cent of total alloy trade.

TABLE 7 **FERROMANGANESE AND FERROSILICOMANGANESE**

World Production and Exports
1984 [3,4,5]

COUNTRY	PRODUCTION		EXPORTS		
	$tx10^3$	%	$tx10^3$	%	Rank
USSR	1 832	27,4	79	5,5	5
Japan	718	10.7	23	1,6	7
China	490	7,3	0		
Norway	480	7,2	422	29,2	1
South Africa	418	6,3	367	25,4	2
France	359	5,4	336	23,2	3
Germany	309	4,6	101	7,0	4
Brazil	285	4,3	21	1,5	8
Mexico	203	3,0	0		
India	168	2,5	0		
Spain	155	2,3	25	1,7	6
Poland	135	2,0	0		
Romania	128	1,9	0		
Italy	124	1,9	12	0,8	10
Canada	116	1,7	9	0,6	11
Australia	106	1,6	0		
Czechoslovakia	100	1,5	13	0,9	9
Other	560	8,4	39	2,7	-
Total	6 686	100	1 447	100	

Ferromanganese consumes less electric power in its production than any of the other common ferro-alloys, which is surely a contributing factor to the wide geographical distribution of producers. Nevertheless, as a result largely of high power costs, all but one production plant in the USA is closed at present. Could this herald a trend in the Western industrialised nations?

Consumption of manganese per unit of steel produced has been on the decline for a number of years, a trend which is expected to continue for some time. This is reflected in manganese ore production which declined from 26,7 million tons in 1979 to 22,5 million in 1985 with very similar amounts of steel produced.

The dominant constraint on manganese usage has its foundations in modern steel technology trends. The steelmaker has succeeded in retaining larger amounts of the manganese, which is added to the blast or pre-reduction furnace, in the hot metal. Growth in continuous casting, which has reduced primary scrap generation, has aided and abetted this trend. Furthermore, the enormous strides made by steelmakers in reducing the concentrations of such elements as carbon, sulphur and phosphorus in steels has given rise to a marked reduction in manganese requirements for deoxidation and desulphurisation and also as an alloying element in certain types of steel. This trend is, however, partially countered by the increasing use of manganese as an alloying constituent in other steel types. The ferromanganese producer now faces an enormous challenge to decrease the content of elements such as phosphorus, sulphur, boron, nitrogen, and carbon in the alloy. After all, the steel producer having gone to great lengths to reduce the content of these elements, has no desire to reintroduce them through subsequent alloy additions.

As with chrome, however, a shift in the type of raw material required has already manifested itself. More ore is being used, largely at the expense of the high carbon alloy. Ferrosilicomanganese is now more popular than ever before and competes with ferrosilicon. It is the number one choice if phosphorus and nitrogen additions are to be minimised. The versatility of the steelmaker in his choice of manganese containing materials has increased. Future expectations are for a shift from one manganese source to another as economics and technological circumstances dictate.

Vanadium

Economically exploitable deposits of vanadium are probably more limited in geographical extent than almost any other mineral commodity (Table 8). Through 1986, the three South African producers could well prove to be the only substantial suppliers,

TABLE 8 **VANADIUM**

World Reserves, Production and Exports - 1985 [2,6]

COUNTRY	RESERVES		PRODUCTION			EXPORTS		
	$t \times 10^3$	%	t	%	Rank	t	%	Rank
South Africa	7 800	47,8	25 027	46,0	2	22 018	68,0	1
USSR	4 080	25,0	12 000 e	22,0	1	0 *		
USA	2 180	13,2	5 312	9,8	4	2 438	7,5	4
China	1 630	10,0	8 016	14,7	3	4 536	14,0	2
Finland	90	10,0	3 175	5,8	5	2 500	2,7	3
Other	540	0,5	900	1,7	-	900	2,8	5
Total	16 320	100	54 430	100		32 392	100	

* Imports pentoxide and ferrovanadium from the West

unless the Chinese make additional material available. The two plants in Finland are reported to have closed and only one plant remains operational in the USA. The Comecon Bloc is a net importer largely from Western ferrovanadium producers. New facilities in Canada and New Zealand are expected to commence production on a modest scale during 1987, and in the USA a new solvent extraction plant for claiming vanadium from Venezuelan flexicoke is likely to be commissioned later this year. Output from petroleum sources represents about six per cent of the total.

Western production capacity, estimated at 40 000 tons is well in excess of demand, hence supplies are more than adequate for the foreseeable future with consumption for 1986 unlikely to be above 1985 levels. Western ferrovanadium production is concentrated in various industrialised nations which, with the exception of the USA, use imported vanadium pentoxide or slag.

Small additions of vanadium impart important properties which are eagerly sought after for the superior steels of tomorrow. Future consumption growth is thus assured.

Ferrosilicon

Ferrosilicon is produced in no less than 28 countries and all, excepting only Norway and Iceland, have substantial steel making capacity (Table 9). Reductants are usually the only raw materials that need to be imported, hence the most important prerequisites for a viable ferrosilicon industry are low cost electric power, sound management and a high operating efficiency. It is therefore not surprising that Norway with its hydro-power dominates the export market in the alloy, trading a massive 427 000 tons in 1984. A substantial oversupply situation is usually a feature of the market although periodic shortages, caused by production cut-backs due to unrealistically low prices, accentuate the high price fluctuations that are of such

TABLE 9 FERROSILICON

World Production and Exports - 1984 [3,5,7]

COUNTRY	PRODUCTION		EXPORTS		
	$tx10^3$	%	$tx10^3$	%	Rank
USSR	750	23,9	46	4,8	6
USA	445	14,2	7	0,7	12
Norway	410	13,1	427	44,2	1
China	195	6,2	4	0,4	13
Brazil	171	5,4	90	9,3	2
France	154	4,9	82	8,5	3
Japan	153	4,9	0		
Yugoslavia	100	3,2	46	4,8	6
South Africa	90	2,9	40	4,1	8
Canada	80	2,5	35	3,6	9
Italy	71	2,3	14	1,5	10
Iceland	63	2,3	63	6,5	5
Germany	60	1,9	80	8,3	4
Spain	60	1,9	8	0,8	11
Others	339	10,8	23	2,4	-
Total	3 141	100	965	100	

concern to steelmakers. The economic balance between ferrosilicon and ferrosilicomanganese is well understood and used with effect by an increasing number of consumers.

Mean ferrosilicon consumption per ton of primary crude steel, although varying from country to country, has fluctuated little over the years, and no change in this situation is foreseen. Consumption is related to liquid steel, however, with progress in continuous casting and its positive effect on yields minimising primary scrap generation, overall ferrosilicon consumption is, of course,declining. Stainless steel production is growing faster than plain carbon steels and, using 10 to 12 kg of ferrosilicon per ton against 2 to 4 for the latter, is a plus factor for the alloy.

With world ferrosilicon capacity in excess of 2,6 million tons, and demand at 1,7 to

1,8 million, oversupply will remain a feature of the market for many years, especially with greenfields projects on the drawing boards in Brazil and other countries, even Western Europe, believe it or not. Some growth is anticipated however with consumption probably exceeding 2 million tons by 1990.

Other Ferro-alloys

Supplies of molybdenum, tungsten, niobium, titanium and mischmetal are all in excess of current demand and likely to remain so. Prices have decreased substantially from their peaks of the late 1970's. This applies particularly to molybdenum , where the recent closure of one mine has resulted in some modest price increases. With all these commodities, supplies remain plentiful and no substantial price escalations are envisaged.

To sum up then, the ferrous raw material supplier, whether he be an ore, ferro-alloy or metal producer, can expect to experience a bumpy road in the years ahead. Oversupplied, highly competitive markets are likely to be the order of the day. The pressure is on for quality improvements and the lowering of impurity levels. The need to remain in the technological forefront has never been more pressing. While the dollar continues to weaken but still remains sacred as the international currency in which marketing agreements are drawn, most raw material suppliers are likely to receive progressively less for their commodities in their own currencies. This trend is being further accentuated with prices in dollars coming under pressure.

For the ingenious, however, the opportunities are obvious. Those to prosper will be the producers with the wisdom and foresight to ensure marketing quality and cost control as the priorities of management, where the increasing sophistication of consumer needs are recognised in the supply of specific qualities. The successful producers will stay in business by assisting their steel-making customers to stay in business. Surely the opportunities are there for all to grasp and thereby succeed in the longer term.

FUTURE PATTERNS IN STEEL PRODUCTION

The oil price escalations of 1973 and 1974 profoundly affected all Western steel producers which was reflected in 1975 by major shutdowns of over-optimistically installed capacity. The result was a sobering relook at steel usage, a major rationalization of the industry, and the commencement of an era of greater sophistication in steelmaking. The days of wasteful resource utilization were numbered, with the emphasis moving towards greater efficiency, lower bulk, and reduction in weight through the use of superior stronger steels (Table 10).

The modernization of plant and scrapping of outdated equipment became a priority. Survival depended upon greater efficiency, lower cost production and superior steel - the race was on.

Even before 1974, steel intensity (crude steel production per unit of GDP per capita of population) in the USA and Western Europe was on the decline and had levelled out in Japan. Before the end of the decade, world steel intensity had also peaked with only the special steels, exampled by stainless steel, still showing growth.

TABLE 10 CRUDE STEEL PRODUCTION - 1985 [8]

COUNTRY	1985 tx10^6	85/84 %	85/79 %	90/85 %
1. USSR	155,2 e	0,6	4,1	0
2. Japan	105,2	- 0,3	- 5,8	- 8
3. United States	80,4	- 4,3	- 35,0	- 10
4. China	46,5	7,2	34,8	+ 20
5. FR of Germany	40,5	2,7	- 12,1	- 8
6. Italy	23,7	- 1,3	- 2,1	- 2
7. Brazil	20,5	11,3	47,2	+ 16
8. France	18,8	- 0,9	- 19,4	- 8
9. Poland	16,1 e	- 2,6	- 16,2	+ 4
10. United Kingdom	15,7	4,1	- 25,6	- 5
11. Czechoslovakia	15,2 e	2,5	2,6	0
12. Canada	14,7 e	0,1	- 8,3	- 2
13. Romania	14,4 e	- 0,3	11,6	+ 4
14. Spain	14,2	5,4	16,0	+ 5
15. Rep of Korea	13,5	3,9	77,9	+ 30
16. India	11,1	5,6	10,0	+ 15
17. Belgium	10,7	- 5,4	- 21,0	- 12
18. South Africa	8,6 e	11,3	- 3,0	+ 3
19. DPR Korea	8,4	29,2	55,6	+ 20
20. German Dem Rep	7,9 e	3,7	11,8	+ 5
21. Mexico	7,3	- 2,8	2,1	+ 8
22. Australia	6,4	1,3	- 21,4	+ 5
23. Netherlands	5,5	- 3,8	- 4,9	- 5
24. Taiwan	5,1 e	1,8	60,1	+ 25
25. Turkey	5,0 e	15,2	1 06,6	+ 35
26. Sweden	4,8	2,0	1,4	0
27. Austria	4,7	- 4,3	- 5,2	- 2
28. Yugoslavia	4,4 e	4,5	24,8	+ 10
29. Luxembourg	3,9	- 1,1	- 20,3	- 5
30. Hungary	3,7 e	- 2,7	- 6,6	0
31. Venezuela	3,0	9,6	105,8	+ 10
32. Bulgaria	3,0 e	2,5	18,9	+ 5
33. Argentina	2,9	11,0	- 8,1	+ 50
34. Finland	2,5	- 4,3	2,2	0
Others	16,4	9,7	32,6	+100
World Total	719,9	1,4	- 3,6	

Let us look at this picture in greater detail. Figure 1 shows the separate production patterns for countries commonly regarded as the industrialised West, the Comecon countries of Eastern Europe and the Developing Nations. The 48 per cent drop in US steel production from 150,2 million tons in 1973 to 77,6 in 1982 was nothing short of catastrophic and even the recovery to 89,6 million tons in 1984 was not exactly impressive (Figure 2). Fortunately, Western Europe and Japan weathered the storm much better than the USA, thus cushioning the overall drop to 28,6 per cent (from 449,6 in 1973 to 320,8 million ton in 1982). After what is generally regarded as a good 1984, the downward trend again manifested itself in 1985. In contrast the Comecon countries maintained a slow but steady growth throughout, which highlights the degree of their industrial isolation from the economic swings of the West.

The developing nations, in sharp contrast to both the Western and Eastern blocs, have shown persistent growth with production levels more than doubling in the 12 years from 1973 to 1985. The Republic of Korea and Taiwan recorded ten-fold increases, Brazil trebled output to become the World's seventh largest producer and China almost doubled output to 46,5 million tons, thus joining the big league with the World's fourth largest steel industry.

If the events of the past twelve years can be used as a guide to the future, the areas of future growth are easy to identify.

South American output should increase up to the turn of the century but former optimistic forecasts of 5 per cent per annum are likely to be dampened by financial constraints; imports will remain at a high level.

On the African continent, growth is projected for South Africa, some of the Arab States to the north and possibly Nigeria. Steel production in the stagnant Third World economies that comprise the rest of Africa is unlikely to emerge before the next century.

The Middle East with its oil incomes should, if political instability does not escalate, show very substantial growth both in production and consumption, albeit from a very low base.

Although China's steel industry has grown rapidly, a pause for reflection and consolidation may well be necessary. Nowhere else does such scope for modernisation present itself and this cannot be delayed indefinitely. Growth there will be, but it will fall far short of projections. Substantial steel imports are likely to remain the scenario for the short to medium term.

In the South East Asian basin, a number of states are likely to follow the example of Japan, Korea and Taiwan and bludgeon forth with substantial steel industries of their own.

For the former great steel producers of the West, all is not lost, however. From here will evolve the expertise to take world steel into the next phase of technological development. Tonnage may well decline but quality and sophistication will come increasingly to the fore, manifesting itself in superior grades of stainless, HSLA and many other classes of specialised steels.

CONCLUSION

The general shortage of raw materials which gave rise to the "sellers" markets that so frequently characterised mineral supply up to the end of the 1970's are not likely to recur for many years. In ferrous metals, surplus capacity, intense competition and highly competitive prices have become the order of the day, and little change is anticipated in the foreseeable future. The occurrence of inordinately low prices will, at times, however, result in temporary supply shortages due to mine and plant closures.

The very survival of mines, alloy plants and steelworks is more than ever before related to their ability to meet high standards of quality control, produce efficiently, manage effectively and, above all, meet the increasingly stringent requirements of their customers.

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REFERENCES

1. United Nations Conference on Trade and Development, Integrated Programme for Commodities. Fourth Preparatory Meeting on Iron Ore, "Statistics on Iron Ore". Geneva, 21 Oct 1985

2. US Bureau of Mines, Mineral Commodity Summaries 1986. United States Department of the Interior, Washington, USA.

3. G J Lofty et al, World Mineral Statistics 1980-1984, British Geological Survey, preprints, Feb 1986

4. The Tex Report, "M C Report on Manganese" Vol 17 No 3983 - 3992, Japan, July 1985

5. John Spooner et al, Mining Annual Review 1985, Mining Journal, London, June 1985

6. Highveld Steel and Vanadium Corporation, Annual Report 1985, Johannesburg, Dec 31, 1985

7. Steve Whitehouse, "More restructuring on ferro-silicon horizon", Metal Bulletin No 7056, 28 Jan 1986

8. International Iron and Steel Institute, Steel Statistical Yearbook 1986, Brussels 1986

Figure 1. WORLD STEEL PRODUCTION BY SECTOR 1973-1985

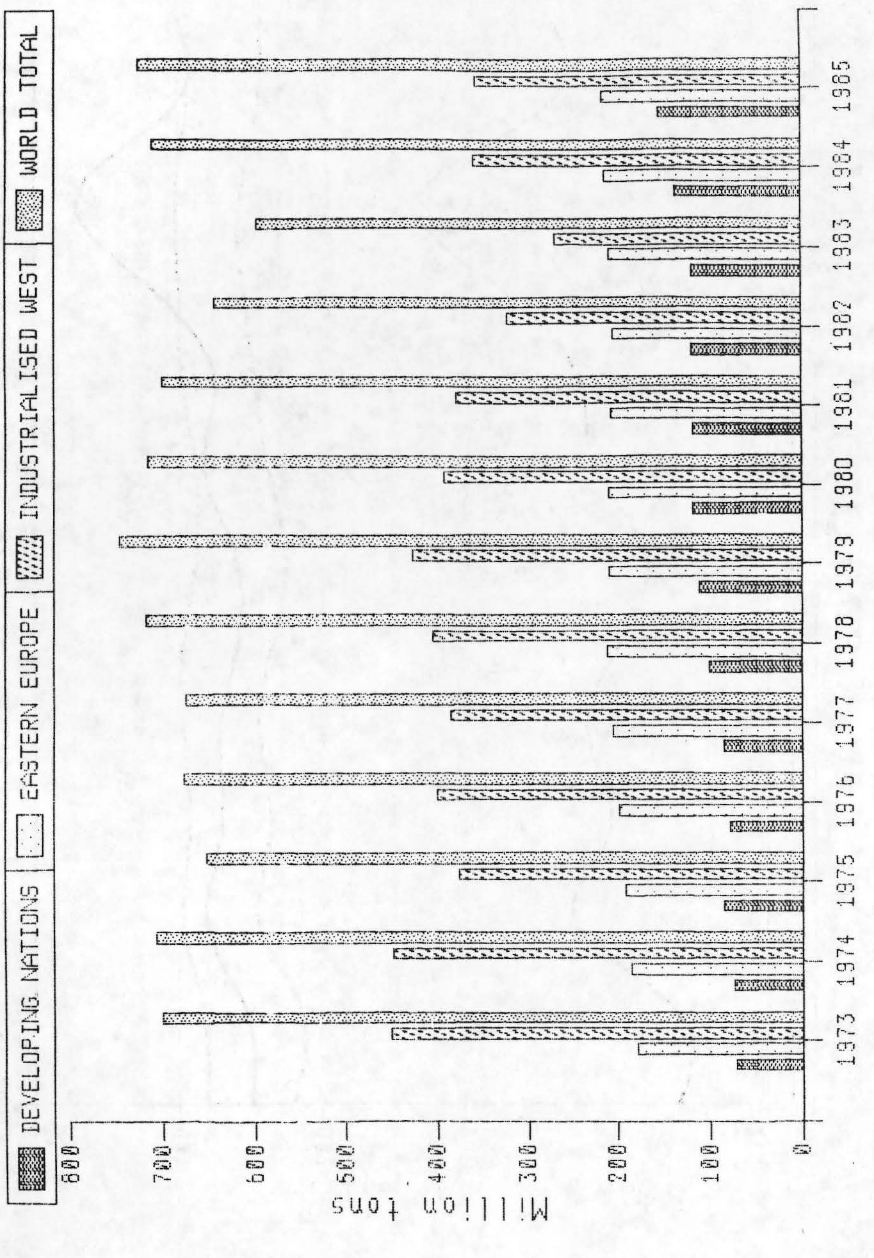

Figure 2. WESTERN WORLD STEEL PRODUCTION 1973-1985