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REVIEW OF WORLD IRON ORE SITUATION - 1966

by

R. W. L. King

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HISTORICAL AND TECHNOLOGICAL BACKGROUND

The blast furnace - steel furnace complex based on coking coal, iron ore and ferrous scrap continues to be the principal steel producing method. The electric furnace method based on scrap is of comparatively minor overall importance. However, where very cheap power is plentiful and coking coal not available, this is often the cheapest method for supplying a limited or special market, or using raw materials unsuited to the conventional process. Interest in various direct reduction processes has been at a higher level in recent years, but in only a very few special cases have these processes been placed in commercial operation.

Regardless of the method used, iron ore is the basic starting point for production of new ferrous material. For a basic and capital intense industry such as steel production, access to a relatively inexpensive, reliable and long term supply of iron ore is essential. Most steel industries have established bases of supply for 20 to 50 years ahead of actual requirements.

By the end of World War II the United States had become concerned about the declining availability of traditional medium grade direct shipping ores in the Lake Superior district, in relation to projected requirements. As a result, many United States firms commenced a world wide search for high grade ores, particularly in Canada, South America and Africa. In the United States, action was taken to intensify research into beneficiation of medium grade ores and iron formation which would not be regarded as ore without concentration.

New discoveries of high grade ore in Canada, Venezuela and Liberia resulted, and by 1955 large tonnages were being produced from these and other deposits from the first post-war wave of new construction. The rate of exploration was stepped up during the fifties because of the increased demand for higher grade ores by Europe and Japan. A second wave of new construction in African, Asian and Latin American countries has resulted in the sixties.

Research in the United States led to the establishment of beneficiation plants on raw materials which, because of their physical and chemical composition, were amenable to processing into uniform high grade concentrates and pellets.

Improvements in blast furnace practice leading to increased productivity were a natural consequence of post war increases in the cost of labour and supplies, and in the cost of construction of new plant. This trend to increased productivity introduced a strong bias in favour of higher grade ores and also in favour of blast furnace feed which had been prepared so as present optimum physical conditions in the furnace. As a first step, run-of-mine ore had the fines screened out and these were sintered before feeding to blast furnaces.

Concentrates produced by the earlier beneficiation plants were relatively coarse, and were normally blended with fines at the blast furnace for sintering. This pattern was not applicable to the later beneficiation processes operating on fine grained ores in which fine grinding was necessary for separation of iron minerals from gangue. To deal with these very fine concentrates the process of pelletising was developed for which fine grinding of the raw material was an essential pre-requisite.

The place of the pellet on the American scene was firmly established by the ratification in November 1964 of an amendment to the constitution of the State of Minnesota, protecting mine operators from discriminatory taxes for 25 years. The improved financial climate resulting from this action led to the prompt announcement of decisions by companies to build plants in Minnesota with a combined annual production of 10.5 million tons of pellets.

Blast furnace operators will continue to purchase iron ore on a price-quality basis, but there is no doubt that demands will favour high grade agglomerated materials.

In Europe, the pattern of supply of iron ore has recently tended away from reliance on the low-grade, but often self-fluxing ores mined in relatively close proximity to blast furnaces which was a feature of the industry up to 1960. There has been a decline in production of this material since then. Sweden has been an exporter of high grade ore to Europe for a number of years and production is increasing. Imports of iron ore by European Coal and Steel Community countries increased from 16.8 million tons in 1950 to 59 million tons in 1962.

Pellets have been available in Europe only in limited amounts and most operators have been content to screen out and sinter the fines from run-of-mine ore. Imports of pellets will become of much greater importance in the later sixties as the demand for high grade agglomerates increases. Another factor affecting European patterns of consumption is the improved transport facilities, both for handling larger ships at seaports and for increased range of economic transport by canal barge from the seaports within Europe itself. Indeed it is now possible to take 1500 deadweight ton barges to Thionville, in the heart of the domestic French iron ore country because of canalization of the Moselle River. This more ready availability of high quality blast furnace feed has no doubt further stimulated research into beneficiating the European low grade ores. Considerable improvements in productivity in French iron ore mining have been made in recent years in a effort to maintain the domestic iron ore mining industry.

Another factor influencing the future acceptability of the European ores (which are often high in phosphorus) is the shift in emphasis from the Thomas steelmaking process (using the basic lined Bessemer converter and high phosphorus pig iron) to basic oxygen processes for which low phosphorus pig iron is desirable. Demand for high phosphorus imported ores from Sweden and Wabana in Newfoundland will be affected by this trend.

One point worthy of mention is that the broadening of the base of the United States iron ore supply that took place during the fifties was largely financed by the steel companies themselves, and considerable vertical integration has resulted, particularly in mines and beneficiation plants in the U.S. and Canada, but also extending to mines in South America and Africa.

In the case of Japan, however, the traditional pattern has been one of dependence on imports of ore from a variety of small independent sources, and vertical integration has been slower to develop. It is likely that even at this time the proportion of Japanese capital invested in overseas iron ore mining is relatively small compared to the United States, after making due allowance for the difference in size of the two steel industries.

European steel companies are showing a tendency to vertical integration in sharing the development of new deposits, chiefly in Africa.

Some interesting comparisons in trade patterns were made by Elver, 1964 - see his figures 2-5 attached (at end of paper).

With the increase in Japanese iron ore imports the traditional sources closer to Japan have been able to supply only a proportion of the increased demand and sources further afield have been drawn upon. The average distance for seaborne ore imported into Japan was 2,170 miles in 1950 and 5,110 miles in 1961. West German figures were 1,260 and

3,030 miles respectively while the United States showed a decrease from 3,480 miles to 2,080 miles with an increased proportion of imports from Canada.

RECENT TECHNOLOGICAL DEVELOPMENTS

The use of pyrite or pyrrhotite cinder (a by product of sulphuric acid manufacture) as a source of iron is increasing with the establishment of pellet plants based on this raw material. The International Nickel Company is producing such pellets, while at Trail, B.C. a steel industry has been established on the by-products of the non-ferrous smelter plant.

In Europe and Japan also, this material has been used in the past for blending with other materials as sinter feed, and this trend can be expected to continue wherever local circumstances are favourable.

A second recent development is the introduction of fluxing materials into the sinter plant feed so as to reduce the amount of metallurgical work to be carried out in the blast furnace, and to secure more intimate mixing of raw materials in the feed. Self fluxing pellets can also be produced with the same advantages.

Combination of direct reduction and pelletising has led to the introduction of the pre-reduced pellet, containing 80-90% Fe. Increased productivity from blast furnaces results from use of this feed because the bulk of the metallurgical work has been carried out during the pellet making process. One of the difficulties with direct reduction processes is that the products often require special treatment to prevent re-oxidation. This appears to have been satisfactorily achieved by at least one of the pre-reduced pellet processes. N.K.K. (Japan) was reported to be planning to produce such pellets from 1966 at an initial rate of 170,000 tons/year, rising to 500,000 tons/year. Cheap sinter feed from Goa and Marcona was proposed as the raw material, to be converted by the Lurgi-Stelco process into a super concentrate valued at $30 per ton and containing 85-90% Fe. Another process developed by Midland-Ross is to be tested at pilot plant scale by the Hanna Mining Co. at Nashwauk, Minnesota. A combination of cheap natural gas and beneficiating grade iron ore and absence of coking coal would favour local development of this kind of process.

One of the disadvantages of pellets is that bentonite or some other additive must usually be added to the iron ore concentrate to act as a binder for the unfired material although recently ferrous sulphate has been used for this purpose by one producer. The usual additives lower the grade of the pellet and require heating and fluxing in the blast furnace. To overcome this disadvantage some research has been directed toward hot briquetting of iron concentrates, which agglomerates the material without the need for inert additives. Trials of such feed in the blast furnace are reported to have been carried out in South Wales recently with satisfactory results. It appears that up to 25% of pellets can be replaced by briquettes. Fine grinding is not necessary in preparation of material for the briquetting process.

A recent report from Sweden indicates that a direct reduction proces has been developed which is particularly appropriate for high grade high phosphorus ores. A rotating furnace somewhat similar to that used in the Kaldo steel making process is fed with fine coke, unsintered iron concentrates and oxygen. It is not necessary that the coke be of metallurgical grade. The economics of the process or the scale on which it is being used are not available.

These more recent technological developments are likely to further restrict the demand for direct shipping ores of medium to low grade. Competition will be keen between the various sources of high grade direct shipping ore and beneficiated low grade in the form of sinter, pellets, pre-reduced (metallized) pellets and iron concentrate briquettes.

Looking quite a bit further into the future, the possibility of significant reductions in the cost of steel production by technological development of unconventional steel making processes should not be forgotten. Such processes may well result in a demand for really high grade iron ore concentrates, perhaps containing as little as 1% silica. Such super-concentrates might be produced from high-grade or low-grade ore, the important parameters probably being the simplicity and uniformity of iron mineralogy and grain size limits. These are the very factors governing the suitability of low grade iron ores for beneficiation today. The search for deposits of this nature may be expected to continue throughout the world.

THE JAPANESE MARKET - GENERAL CONSIDERATIONS

As Elver's Figure 5 indicates, Japanese iron ore imports grew from 1.4 million tons in 1950 to 21.8 (22.4) million tons in 1962, 26.3 million tons in 1963 and 31.2 million tons in 1064. (These figures from Mineral Trade Notes, January, 1966). Before the war Mainland China was the principal source of imported ore. Pre-eminence in this field subsequently changed to the Philippines, Malaya and other countries in south-east Asia. Malaya continues to be the principal source with Chile, Goa, Peru and India contributing large quantities. For political reasons it seems unlikely that Japan would develop much trade with China and Russia so as to become dependent on them to any great extent, though a small trade exists, and offers to supply more iron ore have been made.

In contrast with the United States, Japan's blast furnace operators have not gone into the mining of iron ore to any great extent, although stability of imports of raw materials for the steel industry has been recognized by them as being of prime importance. It is with this in mind that Japan has sought new sources of iron ore in India, North and South America and South Africa. Contracts with the traditional suppliers had apparently been on a relatively short term basis of 2-3 years (many of these producers were relatively small operations with limited proved reserves). Medium to long term contracts concluded with more distant exporters for periods ranging from 7 to 15 years were further steps in stabilising the iron ore base of the Japanese steel industry.

Japan's Long-term Contracts for Imports of Iron Ore

(From Metal Bulletin 19/3/65)

Country	Source	Est. Reserves (million tons)	Port	Contract Period	Annual Delivery (1,000 tons)
India	Rourkela (Kiriburu)	170	Vizagapatam	10 years from 1964	2,000
"	Bailadila	680	"	15 years from 1966	4,000
"	Chowgule (Goa)	-	Marmagoa	5 years from 1964	1,050
U.S.A.	Kaiser (Eagle Mtn.)	200	Long Beach	10 years from 1962	1,000
Brazil	Rio Doce (Itabira)	600	Vitoria & Tubarao	15 years from 1966	1,000 - 4,500
Chile	Santa Fe	70	Caldera	10 years from 1961	about 1,000
Swaziland	Ngwenya	30	Lourenco Marques	10 years from 1964	1,200

Some investments in new iron ore mines in Africa and South America were made. Finally, with the discovery of large deposits of high grade and beneficiating ore in Australia, long-term contracts were made for ore and pellets. There was limited Japanese financial participation in some of the operations designed to supply pellets to Japan.

While these long term contracts were essential to the Australian producers for the establishment of mines, railways, ports etc. from the grass roots, they were also no doubt welcome to the Japanese as providing a soundly based, long term, moderate cost supply of high grade materials for the Japanese steel industry. It is important to note that firm agreement on prices over a number of years was a major departure from normal practice by the Japanese - most of their long term contracts are subject to frequent (often annual) negotiation of prices.

The movement of large quantities of overseas ores to Japan involves a considerable freight cost. In recent years efforts have been made to reduce this cost by providing improved port facilities, including provision of raw materials handling centres where it is impracticable to provide suitable deep water at blast furnace plants. Many of these are built on reclaimed land.

The percentage of raw materials carried in Japanese ships is rising as more carrier tonnage is constructed. As improved port facilities are available, larger ships are being built, and prospective exporters to Japan must be able to provide facilities for loading large ships.

Of the iron ore imported in 1961 and 1962, about one quarter was shipped in Japanese ore carriers mostly from Malaya and Goa. One third was carried in foreign owned carriers, mainly from Chile, Peru and Canada. The remainder was carried in tramp ships, primarily from Malaya, Goa and the Philippines. It was expected (1963 - Special Report of British Iron and Steel Institute delegation to Japan) that by 1965 imports of iron ore would amount to 34.5 million tons of which half would be carried in Japanese ships. It is to be expected that this tendency to bigger ships and a greater proportion of Japanese ownership of the tonnage used for raw material imports will continue. More contracts will be written f.o.b. rather than c. & f. A degree of flexibility is also being introduced by designing these carriers so that they may carry oil as back loading.

As Japan must also import a substantial proportion of its coking coal there is an added economic incentive to use high grade blast furnace feeds so as to reduce coke consumption as far as possible.

PRICE MOVEMENTS IN RECENT YEARS.

Elver, 1964, probably using statistics to the end of 1962 and information to the end of 1963, reviewed price changes between 1950 and 1962. See his Figure 6 attached. He recalled that many old and new mines had operated at less than capacity since 1960, although new capacity continued to be installed. The result was described as a downward price reaction tempered by long term contracts and a degree of corporate integration with consumers. In North America the Lake Erie base price for traditional ores is the principal guide to market conditions. A peak reached in 1957 held for quoted prices until 1962, though non-integrated producers offered discounts which increased from 5 to 15% over the period 1960 to 1962. The decline in quoted prices which took place in 1962 amounted to about 7%. The nominal posted price for high grade pellets has not decreased, but as most of the pellet producers are integrated with consumers, the figures quoted are probably not significant. Base prices since Elver's study remained constant in 1963 and fell by 10 c (about 1%) in 1964, remaining constant for 1965 and 1966. Taconite concentrate and pellet prices remained constant at 1962 figures, though this is probably not significant, as pointed out above.

In Europe, Elver regards Swedish contracts with Western Europe as being the best indicator of prices. Based on 1956 = 100 the price of Swedish ore had dropped to 67 by mid 1963, and negotiations for 1964 indicated that a further drop would take place in future.

The declining cost of iron ore imports is further illustrated by the following table of c.&f. values of imports of iron ore and concentrates, provided by the British Minister for Power in mid 1964 in response to a question in the House of Commons.

Values of Imports (Shillings sterling per ton c.&f.)

	1960	1961	1962	1963	1963 in $US
U.K.	98	98	97	91	12.74
Belgium-Luxembourg	37	38	37	37	5.18
Italy	89	87	85	79	11.17
France	93	86	82	75	10.50
West Germany	77	79	74	71	9.94
Netherlands	92	88	80	66	9.24
Japan	103	103	103	98	13.73

When considering these figures, it should be remembered that the bulk of Belgian imports consist of low quality Lorraine ores shipped overland. However, the U.K. and Japanese figures are more comparable since they both apply to high quality imports from overseas sources.

The following table showing Japanese imports and average prices for fiscal 1963-64 and 1964 have been compiled from data in Hamersley Iron Briefs 5 and 17.

Source	1963-4 Tonnage ('000 metric tons	1963-4 Av. price $U.S.	1963 Tonnage ('000 metric tons)	1964 Tonnage ('000 metric tons)	1964 Av. price $U.S.
Malaysia	6,704	12.19	6,697	6,725	12.16
Philippines	1,522	13.09	1,417	1,501	11.39
South Korea	611	11.65	593	664	11.32
Hong Kong	120	13.04	127	132	13.05
Chile	3,527	16.28	3,118	5,417	15.19
Peru	3,338	12.98	2,918	3,494	13.03
Brazil	418	16.30	498	439	16.07
Goa	3,133	11.72	2,998	3,215	11.56
India	3,005	15.41	2,803	3,492	15.14
Canada	1,873	14.27	1,886	1,765	14.25
U.S.A.	2,038	14.00	1,821	2,005	14.02
S. Africa / Rhodesia	1,085	15.89	591	1,023	16.09
Rhodesia				317	15.82
Miscellaneous			508	911	
North Korea	26	10.31			
China	23	10.12			
Formosa	4	8.52			
Thailand	7	12.09			
Singapore	52	13.09			
Europe	26	13.26			

A downward trend in prices is clearly evident.

Japan Metal News for 1964 and 1965 was examined and here there was little indication of any great change in prices. It appeared that any changes made were definitely in the buyer's favour, and it would seem that there is little reason to expect any change in this pattern in future.

Because they have been operating in a buyer's market, Japanese operators have for some time adhered to a policy of maintaining only small stockpiles of ore. They have always been able to rely on spot shipments, usually from Goa, to cover any shortfall. However, early in 1965 the Japanese were experiencing great difficulty in obtaining sufficient iron ore because of a combination of

(a) Labour strikes at mines in Goa, India, Chile and Peru.

(b) A shortfall on contracted deliveries from mines in British Columbia, Malaya and the Philippines due to exhaustion of reserves.

(c) Construction setbacks in India's iron ore development programme, with consequent shortfall of contracted deliveries.

Spot purchases were made from B.H.P. in Australia, LAMCO in Liberia and other sources, not normally used by the Japanese. It would not be reasonable to compare the price of spot purchases such as these with long term contracts such as those with suppliers in South America, Africa and Australia.

At this stage some examination of these long term contracts may be of value. Details of some recent contracts with India, Brazil, Chile, the United States and South Africa have been listed above. Some other contract details are set out below.

(a) State Trading Corporation of India - 11 million tons between 1963 and 1968. It is understood that under this and other Indian agreements prices are subject to review each year.

(b) The price of Santa Fe ore from Chile was quoted as U.S. $16.56 c. & f. for 65% Fe grade (25.3 cents per unit) for 11 million tons of ore from 1961 to 1970. This was reduced after negotiations in 1964 which led to an extension of the contract by 2.55 million tons and to 1971, with f.o.b. prices reduced 86 cents for 1964-65 and $1.04 for 1966-71.

(c) Another contract with Goa by Kawasaki provided for supply of 2.5 million tons over 10 years from 1962, the price of the 58% Fe grade ore was given as $U.S. 5.80 per ton f.o.b.

(d) Contracts with Cia Vale do Rio Doce of Brazil for 50 million tons between 1966 and 1980 included a price of $U.S. 15.84 (24c per unit) for 66% Fe grade run-of-mine ore when made in April, 1962. Between that time and May 1964, theoretical freight rates dropped from $U.S. 7.84 to $U.S. 5.50 per ton. A revised contract was agreed at the end of September, 1964, which provided for an increase in the proportion of the tonnage shipped f.o.b. from 50 to 60%, the price being $U.S. 8.00 per ton. The c. and f. price on 25% of the total tonnage was cut to $U.S. 14.52 (22c per unit) leaving only 15% of the original tonnage to be bought at the 1962 price. The c. and f. portion of the contract is to be carried in 50,000 d.w.t. ore carriers constructed in Brazil in a Japanese owned shipyard. Japanese mills which can only discharge 20,000 tons vessels will be provided for in the f.o.b. portion of the contract. Later information suggests that freight rates of $U.S. 5.70 to $U.S. 6 will be obtained by Rio Doce for the c. and f. tonnage, while a 71,000 ton vessel is to be built to carry part of the f.o.b. tonnage at a rate of $U.S. 4.75. This low freight rate gives an equivalent to c. and f. price of 19.6 cents (U.S.) per unit. Formal contracts signed in December, 1965 covered shipment of 3 million tons only in the period 1966-67. Presumably prices for subsequent years remain liable to renegotiation.

(e) Revision of Swaziland prices negotiated in 1961 was reported in 1964. Shippers wished to use larger vessels and increase the annual tonnage by 250,000 tons. The original contract called for 12 million tons of lump ore delivered between 1964 and 1973. A reduction in the c. and f. price from $U.S. 14.70 (22.6 cents U.S. per unit) to $U.S. 14.12 (21.7 cents U.S. per unit) was agreed to. This represents an even more substantial reduction on the f.o.b. price of $U.S. 9.80 per ton plus freight $U.S. 6.30 equivalent to 24.8 cents per unit c. and f. which was initially agreed to.

The effect of the entry of Australian iron ore and pellets into the market was no doubt partly responsible for these price reductions, though a desire on the part of c. and f. sellers to reduce their freight costs to a minimum by the economics of scale must also have played a significant part.

Discussions between directors of raw materials departments of the major Japanese steel mills took place in September, 1965. The long term supply and demand of iron ore up to 1975 was considered at this meeting and the reported conclusion was that no new long term contracts would be required until 1970 to 1975. Australian exports to Japan should at that time amount to about 17 million tons per year, almost one third of the expected total imports of that country.

FREIGHT RATES AND AUSTRALIAN PRICES

Some recent contracts with Japan are set out on the attached tables 1 to 3, prepared by R. Pratt. Data on freight rates culled from various sources have been tabulated by R. W. L. King, and data on port capacities, also in tabulated form, has been culled from papers of the United Nations Study.

Considering the long term contracts it is notable that only the 50 million-ton contract over 15 years with Brazil is in any way comparable with the Australian contracts, and even in this case, prices are not firm, but subject to negotiation at frequent intervals.

Prices negotiated for pebble ore from Brazil for 1966-67 shipment are 13.1 cents (U.S.) unit f.o.b. and 24.4 cents/unit c. and f. 60% of the tonnage is to be shipped f.o.b. Reported freight charges for largest carriers over the bulk of the contract are around $U.S. 4.80, giving an equivalent c. and f. price of $U.S. 8.50 + $U.S. 4.80 = $U.S. 13.30 or 20.2 cents per unit.

For Australian lump ore bought f.o.b. the equivalent c. and f. price is Hamersley - $U.S. 9.92 + $U.S. 2.40 = $U.S. 12.32 or 19.3 cents per unit. Mt. Newman $U.S. 9.37 + $U.S. 2.85 = $U.S. 12.22 or 19.1 cents per unit. F.o.b. prices are 15.5 and 14.6 cents per unit respectively.

Comparison of the two shows that while the Hamersley f.o.b. price is higher, the c. and f. equivalent price is somewhat lower than that for ore from Brazil. Actually it appears that the savings in freight as compared with Brazil has been shared between the Japanese and Australian companies, with f.o.b. prices higher (by 2.4 - 1.5 cents/unit) and overall cost of ore bought on f.o.b. basis lower (by about 1 cent/unit) than corresponding ore from Brazil.

Similarly in the case of pellets, the same differential is apparent. F.o.b. prices appear slightly higher and c. and f. equivalents slightly lower than other Japanese contracts, which in any case do not provide for such long terms at fixed prices.

Iron Ore Freight Rates

Between	Rate $US per ton	Date	Reference	Remarks
Brazil-Japan	4.95	Report-Sept 1965	JMN 2678	Signal Oil Co.'s offer
	8.00	"	"	C.V.R.D.'s c.&f. freight costs
	4.65	Rptd. offer Oct. 1965	"2609	By Vergesen of Norway
	4.88	Dec. 1965	"2716	Signal Oil Contract 1967-77
	4.80	" "	"2716	Ness-Nippo Contract
	<4.80	Negotiating Dec. 1965	"2716	Caltex Oil
	5.70)	Jan. 1966 -	H.B. No. 25	European Shipping Cos.
	6.00)	Quotations		Japanese " "
Chile-Japan	5.30-5.50	Sept. 1964	H.B. No. 9	Expected spot charter rates for 55,000 tonners. 1965-67
Australia-Japan	2.40	Expected Rates	H.B. No. 2	Hamersley - 60,000 tonners
	2.85	Rptd. in 1964		Mt. Newman - 40,000 tonners
	3.00			Mt. Goldsworthy 30,000 tonners
	3.30			Savage River 60,000 tonners
	2.10	Report Oct.'65	JMN 2668, 2694	Yamashita - 76,200 ton carrier from Hamersley
	2.43	1964	H.B. No. 16	Pt. Hedland shipments - freight allowance - difference between c.&f. and f.o.b. prices offered
India-Japan	6.15)	Fiscal 1964	H.B. No. 3	From Vizagapatam. Lower rate to apply when 30,000 ton carriers accommodated
	3.50)	Shipments		
	increase of 10%	Fiscal 1965	JMN 2627	Japanese Shipping Companies request
	increase of 3%	"	JMN 2646	Agreement - from India
	increase of 10 %	"	JMN 2644	Agreement - from Goa
India-Japan	> 7.00 (50/- stg)	current rate 1965	H.B. No. 19	Rate for 1965-67 MMTC contracts with Japan
Liberia-Japan	6.50	Shipment Jan.-Mar. 1965	H.B. No. 15	Rate for spot purchases early 1965

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Lourenco Marques - Japan	6.30	Agreed 1961	H.B. No. 12	65,000 tonners, long term contract
	4.90 (35/- stg)	Offer 1964	H.B. No. 7	Offer of short term contract
	5.04 (36/- stg)	Nov. 1964 - Mar. 1965 shipments	H.B. No. 7	Spot purchase only
Philippines (Larap)-Japan	2.50	Report - 1964	H.B. No. 3	Possible freight rate for Larap pellets
(Luzon)-Japan	2.80	1965 shipment	H.B. No. 8	Iron sand in 10,000 ton shipments
North Korea (Musan) to Japan (Yawata)	2.85	Shipment 1964	H.B. No. 3	Firm rate after long negotiation Japanese Shipowners
All Ports other than India and Goa to Japan	Same as fiscal '64	Fiscal 1965	JMN 2644	Agreement with Japanese shipowners for 1965 shipment of ore purchased f.o.b. in Japanese ships
Mauretania to North Sea Ports	2.00 approx	Report - 1964	H.B. No. 7	Current rates for 1964 shipments
Liberia - U.S. Coast	5.00	1957	Elver P11	References in Elver's comments on reduction in freight rates
	3.00	1963	"	"
Sept. Isles - U.S. Coast	1.50	1957	"	"
" "	1.00	1963	"	"
Australia-Europe	6.00	1965 estimate	Steel Times 31/12/65 p.825	Estimate of freight rate that might apply to sales of W.A. ore to Europe
General	50 U.S. cents per 1000 ton miles	1966 estimate	Northern Miner 31/1/66	Estimate of likely future rates in 100,000 ton carriers presented to 39th Annual Meeting Minnesota Section of A.I.M.E.

Note: H.B. = Hamersley Iron Ore Brief

JMN = Japan Metal News

Elver = Economic Aspects of Iron Ore in a Changing Market by R. B. Elver - Mineral Information Bulletin MR74 of Department Mines & Techn. Surveys, Ottawa

Data on Port Capacities

Port Location		Depth	Carrier Capacity (D.W.T.)	Loading Rate (tons per hour)
Narvik	Norway		35,000 (all year)	
Oxelosund	Sweden		"	
Lulea	"		35,000 (5 months only)	
Kirkenes	Norway9		27,000 (all year)	
Mo-I-Rana	"		?	
Bona	Algeria	9 meters	20,000	2,000
La Coulette	Tunis	9 meters	20,000	2,000
Melilla	Morocco	30 meters	v. large	1,200
Port Etienne	Mauretania		60,000	3,000
Can be further developed to			100,000	6,000
Pepel	Sierra Leone		35,000	
Conakry	Guinea			
Monrovia	Liberia		35,000	Mano & Bomi 2,500 conc 1,700 lump Bong 4,000
Buchanan	Liberia		45,000	6,000
Can be developed to			60,000	
Mekambo deposit - Gabon			65,000	6,000
Port to be developed				
Mocamedes	Angola		60-100,000	?
(after proposed development)				
Lourenco Marques	Mozambique			3,700
Puerto Ordaz	Venezuela		60,000 limited 50,000 ton low water seasons	6,000
Palua	"		60,000 but limited to 50,000 low water season	3,000
Vitoria	Brazil		1-35,000	2,000
			1-35,000	900
Tubarao	Brazil		60,000	6,000 by 1966
(being developed near Vitoria)			100,000	12,000 by 1970
Rio de Janiero	Brazil			Only capable 2 million tons per year

Data on Port Capacities (continued)

Port Location	Depth	Carrier Capacity (D.W.T.)	Loading Rate (tons per hour)
Punta de Adolfo Brazil			
(to be developed - requires railway line also)			Capacity 10m /year
San Juan Peru		50,000	4,000 (lump)
San Nicolas "		100,000	4,000 (concentrates & pellets)
Guayacan Chile		50,000	3,000
Huasco "		50,000	2,500
Chanaral "		50,000	2,000
Caldera "		50,000	2,000

NEW DEVELOPMENTS WHICH MAY AFFECT THE JAPANESE MARKET AND MARKET FOR AUSTRALIAN IRON ORE

Generally speaking deposits which might possibly be competitive in Japan have been considered i.e. African deposits and eastern South American deposits are considered as well as those whose normal outlet would be to the Pacific Ocean. Some deposits whose normal market would be Europe or the United States are also mentioned as they may have a secondary effect in deflecting African or South American production toward Japan. All data is as quoted in the sources consulted and the Bureau cannot accept responsibility for its reliability.

Alaska. A deposit 200 miles south west of Anchorage has been discovered by a Standard Oil of Indiana subsidiary. The deposit is estimated to contain 1,000 million tons of iron, but is of low grade (15-20% Fe) though readily concentrated. The deposit is close to ice free water and within easy pipeline distance of natural gas reserves in the Cook Inlet area. A Japanese report states that magnetic separation can produce a 62% Fe concentrate which can be further upgraded to 90% Fe by a natural gas based direct reduction process. The distance from this area to Japan is about the same as from Malaya to Japan. Two Japanese companies are interested in future developments in the area and are studying the project further. A recent report from the United States Geological Survey extends the area of iron mineralization 50 miles west of the deposits reported above, and indicates that about 1% titanium is also present.

Alberta, Canada Peace River Mining and Smelting Limited has offered 3 million tons per year of sponge iron to Japan, to be produced from 35% Fe grade deposits in Northern Alberta using local natural gas or oil. A slurry pipeline has been proposed to move the sponge to the shipping port of Price Rupert, approximately 600 miles away.

Yukon, Canada Crest Exploration Ltd. is a subsidiary of Standard Oil of California formed to explore and develop the Snake River iron ore concession in the Yukon Province of Canada. The ore ranges from 30% to 50% Fe and also contains 0.3% to 0.4% phosphorus. A column flotation process has been developed which, it is claimed, will reduce the phosphorus content and upgrade the iron. Study of a 400 mile slurry pipeline from Snake River to Skagway is planned.

Mexico Exports of iron ore in recent years have varied from time to time, but have been generally small, the United States being the principal importer. Estimated reserves of iron ore are said to be 570.4 million tons with an average grade of 57% Fe. Production for domestic requirements runs at about 1.4 million tons per year and reserves appear ample for the development of an export industry. Proposals have been made to develop the El Cleston deposit for export to Japan. 2.1 million tons of lump magnetite in the range 63-58% Fe was offered for delivery over the period 1964-67. A second lower grade deposit, Pena Colorado, was examined by the Japanese but was ruled out as uneconomic because of the royalty of 25% of the f.o.b. price imposed by the Mexican Government.

Marcona, Peru Iron ore production in Peru increased from 6.0 million tons in 1963 to 6.5 million tons in 1964. Marcona Mining Company has a reserve of 400 million tons on the coastal plateau 220 miles south of Lima. A second pelletising plant capable of 2 million tons of pellets per year is to be erected at the port of San Nicolas. Costing an estimated $U.S. 23 million the new plant is expected to commence operations in the first half of 1967. Due to depletion of direct shipping ore, the expanded beneficiation facilities will not lead to an increase in exports beyond the present level of 5.5 million tons of ore and concentrates. The average grade of 1964 exports from Peru was 63.8% Fe. A total of 35 million tons of ore and pellets had been exported by Marcona by February, 1964. Pellet shipments commenced in August, 1963, and were initially regarded by the Japanese as unsatisfactory because of their tendency to crumble and swell during transit. The type of kiln used for firing the pellets appears to have been the cause of this difficulty.

Chile Exports in 1964 (9.1 million tons) were higher than 1963, in spite of losses due to strikes. It was reported that by 1970, 1961 production would have been increased by 6 million tons (87%). The capacity of the Algarrobo mine of Cia Acerro del Pacifico has been increased to 3.5 million tons per year. Bethlehem-Chile Iron Mines (El Romeral and El Tofo Mines) is increasing efficiency and quality of product without increasing production, while Cia Minera Santa Fe Mining Co., which controls a number of medium and small sized mines, has been increasing capacity and intends improving quality over the next few years. Reserves of iron ore in Chile are estimated at 1,000 million tons.

Exploration of the Chanar-Boqueron deposit north of Vallenar was reported to be in progress in September, 1965. A preliminary estimate of 70 million tons of high grade ore had been made. Several overseas companies were reported to be interested in obtaining the mining rights to this deposit.

Another operator, World Commerce, which ships from Santa Barbara mine through Huasco has successfully proposed exploitation of the Bandrias deposit. The lump ore is reported to average 60% Fe, and proposed shipping rate 500,000 tons per year. A contract was finally concluded for 62% Fe grade lump ore, 4 million tons to be taken over a 5 year period from September, 1965.

Bolivia In this country technical studies have been carried out under United Nations auspices on the development of the Mutun deposits located in eastern Bolivia near the Brazilian border. The study included transportation problems and particularly the shipment of ore down the Paraguay-Parana River system. Deposits are reported to range 53-58% Fe and contain at least 49 thousand million tons of iron ore and 30 million tons of manganese ore. A minimum investment of $U.S. 136 million would be required to bring them into production according to the study. A mixed corporation with the Government supplying 30% of the capital was suggested. Transport will be a major problem - Arica in Chile is 600 miles away, Buenos Aires on the Atlantic 1,000 miles.

Argentina Total deposits of iron ore in the recently examined Sierra Grande region are estimated at 200 million tons. The area is located about 15 miles from the coast of Northern Patagonia. Argentina is at present an importer of iron ore from Brazil and Chile for the San Nicolas coastal steel plant near Buenos Aires. Proposals for development of the Sierra Grande deposits were not reported to include export of iron ore.

Brazil With 1964 production estimated at 15 million tons, Brazil is one of the world's largest producers of iron ore. Further expansion proposed includes a second pellet plant. As well as being under a long term contract with Japan, Brazilian producers are also reported to have arranged very large contracts with European consumers. An iron ore pellet plant has been proposed for the Casa Pedra mine of Cia Siderurgica National; half the annual production of 1.5 million tons is expected to be available for export.

Papua In mid 1965 a Sydney company was reported to be examining the possibility of exploiting black sand deposits in the Gulf of Papua, using natural gas to produce 500,000 tons of iron ore pellets annually for export to Japan. We have heard nothing recently of progress made by this company. Magnetite sands dredged from the ocean form a significant part of Japan's admittedly small domestic iron ore production.

Philippines 1964 exports (1.52 million tons) were a slight increase over 1963 figures; all exports were to Japan. Philippine Iron Mines at Larap are constructing a pelletizing plant consisting of 3x250,000 ton per year capacity Kawasaki shaft furnaces. Pellets are coarse (20 mm) and average 65% Fe. In view of the low cost of the pellet plant and the short distance from Japan, buyers were hoping for a c. and f. price somewhat below that being paid for Marcona pellets. It was expected that iron sand would form part of 1965 and subsequent export shipments from the Philippines. A shortage was being experienced of supplies of iron sand from Japanese sources when this sale was negotiated in 1964. The exporter indicated willingness to supply additional tonnage in future years if required.

India National Minerals Development Corporation is reported to be examining a deposit said to contain 4,000 million tons of magnetite ore 25 miles from Mangalore. 39 miles of railway would be required to connect the deposit with the port, and exports of ore fines upgraded by screening to 65-67% Fe at the rate of 2 million tons per year were contemplated. The Corporation hoped to secure Japanese assistance for further exploration and feasibility studies; these were expected to begin in December, 1965.

Iron ore production in India, exclusive of the 5.6 million tons produced by Goa, amounted to 14.9 million tons in 1964. Expected output during the last year of the Third Plan (1965-66) was reported as 29 million tons and the Fourth Plan target for 1970-71 is 63 million tons, of which 30 million tons is intended for export. 1964 exports amounted to 10.5 million tons (including Goa).

Six different ports are to be developed for iron ore shipment. Paradip is to be increased first to a capacity of 2 million tons per year and later to 5 million tons. Madras is to be increased to 3 million tons per year, accommodating ore carriers of up to 30,000 tons. Marmagao is to be increased to 10 million tons per year capacity and Haldia (near Calcutta) Mangalore and Kakinada (south of Visakhapatnam) are also to be expanded. Completion of 234 miles of broad gauge railway to Hospet has been proposed for development of iron ore reserves to supply 4 million tons per year for shipment through Marmagao.

Long term contracts were concluded with the Japanese some years ago for the sale of ore from the Kiriburu deposit, but implementation was delayed because of failures to adhere to the programme for railway and port facility construction. However, 1966 is expected to be the first full year of exports from this area, using the improved facilities.

Bailadila is being developed for a long term contract of 4 million tons a year for 15 years. Construction is to be completed in 1966. Studies are being carried out as to feasibility of a 2 million ton per year pellet plant to utilize fines generated in prâparing the contract tonnage.

In November, 1964, Chowgule & Co. (Goa) commenced construction of a beneficiating and pelletizing plant estimated to cost $U.S. 8.4 million. The Output of 500,000 tons of pellets per year was to be sold to Japan. More recent reports indicate that shipments will not commence until January, 1967.

At the end of 1961, Indian reserves of iron ore were estimated at 21,336 million metric tons. It was reported that in 1964-65 the state owned Mineral and Metals Trading Corporation of India incurred a huge loss on the export of iron ore for the third successive year.

Barter trading is a feature of iron ore exports to Japan and Eastern Europe which makes Indian ore attractive in spite of its relatively high price. Provision for barter payment in oil and capital goods was included in a recent sale of 1 million tons of ore to Rumania for 1966 delivery.

Following Indian acquisition of former Portugese colonies in India, the Indian Freight Tax on the earnings of non-resident owners and charterers is being applied to these former colonies in stages ranging from 55% of full rates in 1964-65 financial year to full rates in 1969-70. This scheme will erode the competitive advantage previously enjoyed by Goanese producers over those from other parts of India.

Mozambique Interest in deposits near Manapa has been shown by companies from Germany, Japan, Britain and the United States. The high grade deposits contain columbite, tantalite and tin as well as iron oxides. It has been announced that a dam is to be constructed on the Lurio River about 6 miles away, from which hydro-electric power would be available. A new bulk facility has recently been opened near Lourenco Marques in Mozambique. Costing $U.S. 4.5 million the facility has a storage capacity of 800,000 tons and can load at 3,700 metric tons per hour. Iron ore from Bomvu Ridge (Ngwenya) in Swaziland is being loaded into 65,000 ton carriers for shipment to Japan.

Angola Production during 1964 was almost 1 million tons, an increase of about 40% on 640,000 ton production in 1963. In June, 1965, it was announced that the Cassinga deposits were to be developed by Companhia Mineira de Lobito and Krupp. Investment of $U.S. 62.5 million was expected and as a result iron ore production would be increased by 4.5 million tons per year. Reserves of 63% Fe grade ore are said to exceed 100 million tons, while reserves of 35-53% Fe grade material are much greater still. A 5 year contract covers shipment of 800,000 tons per year to blast furnace plants in the Ruhr. A rail haul of 400 miles to the port of Mocamedes is involved. Japanese Steel Mills were reported in June, 1965, to be interested in an offer of 15 million tons of 64% Fe run of mine ore from Lobito over 10 years to 1976. Mocamedes is capable of handling large ore carriers similar to those to be used for Western Australia.

Gabon Investigation of the possibility of building a railway to serve the Belinga iron deposit of Societe des Mines de Fer de Mekambo (SOMIFER) was completed in 1965. Construction of the line is to begin in 1968. Capacity will be 10 million tons of iron ore, 1 million tons of raw wood and 50,000 tons of agricultural and other products annually. Testing has verified the existence of large economically exploitable iron ore deposits near Minkebe 45 miles north west of Belinga. The Republic has an estimated 2,000 million tons of high grade iron ore; production is expected to begin in 1974.

Liberia 1964 output of iron ore amounted to 11.5 million tons. Development of the Mount Nimba deposit by the Liberian American - Swedish Minerals Co. (LAMCO) was completed during 1964. 7.2 million tons were produced and 6.8 million tons exported. 1965 production was expected to reach 8 million tons. LAMCO has announced the construction of a pellet plant at the port of Lower Buchanan, with construction scheduled to be finished late in 1967. When this is completed production capacity will be increased to 10 million tons per year.

In September, 1964, an announcement was made that a new iron ore concession agreement had been concluded with the Government for development of the Mt. Kitoma deposits said to have reserves of 750 million tons in the range 40 to 60% Fe. grade.

The Bong Range deposits, estimated to contain 300 million tons of 38-42% Fe grade material have been brought into production recently by a company in which the Liberian Government and a West German consortium are shareholders. The ore is concentrated to 65% Fe grade before export to Germany and Italy through the port of Monrovia approximately 70 miles away. Exports were expected to amount to 1 million tons in 1965 and 3 million tons in 1966.

About 25% of Liberian exports go to the United States, the remainder to Europe. It is estimated that by 1967, 19.5 million tons of iron ore will be exported annually through Monrovia and Lower Buchanan and 25 million tons by 1970.

Sierra Leone Exports for 1963 and 1964 were both slightly below 2.0 million tons. Sierra Leone Development Co. recently completed a $U.S. 25 million expansion programme improving loading, rail transport, mining and milling facilities. Capacity has been increased by 40% to 2.8 million tons of 64% Fe grade material per year.

Mauretania Exports from the principal company (MIFERMA) amounted to 4.6 million tons in 1964, the first full year of production. It was expected that 1965 production would be 6 million tons and 1966 production 8 million tons. New deposits are reported to have been discovered near the deposits presently being worked in the north near the Rio de Oro border. Size and quality are said to be almost the equal of the deposits being exploited.

Morocco The traditional markets for iron ore from Morocco are France and Germany. Exports fell from 1.9 million tons in 1960 to 0.8 million tons in 1963 and rose to 1.1 million tons in 1964. One mine is planning a programme of shaft sinking and underground development to increase capacity to 1.2 million tons per year.

Pyrrhotite cinders rich in copper are a by-product of the Safi chemical fertilizer complex recently brought into production. Further processing of the annual production of about 380,000 tons of this material is being considered. There is potential for production of 3,000 tons of copper and an unspecified quantity of iron oxide pellets containing 66% iron.

Portugal If the navigability of the River Douro can be improved, exports of 1 million tons of iron ore pellets may take place through Oporto. The interested mining company states that exports could increase to 2-3 million tons per year later. Iron ore shipments from Portugal have fallen over recent years to less than 100,000 tons per year.

Baffin Island Baffinland Iron Mines Ltd. holds a development licence for the deposit which was recently discovered. Tonnage is reported to be 135 million and grade 68 to 70% Fe with low silica and phosphorus content. The shipping season at this latitude (within 17° of the North Pole) is limited to two months because of ice, and this will be a significant drawback to development of the deposit. The exploration company has spent $1 million in the area and hopes to start producing by 1970. The Canadian Government is contributing toward the cost of company built airstrips and is to help build a railway to Milne Inlet from the deposit at Mary River.

<u>Port Development in Europe</u> Any possibility of sales of Australian ore to Europe will depend on the availability of very large ore carriers to reduce freight rates to a minimum. While facilities for loading these carriers will be available, European consumers will only be able to consider Australian ore if they have access to ports capable of handling these large carriers.

Last July, proposals to develop ports in South Wales capable of handling more than 10 million tons of ore per year were revealed. Carriers to 65,000 tons will be handled, and it will be possible to develop these ports to take 100,000 d.w.t. ships. At about the same time, John Brown & Co. (Clydebank) Ltd., put forward proposals for a new wet dock at Glasgow which could unload 100,000 ton carriers, in association with development of three new ship-building berths capable of constructing ships up to 260,000 d.w.t. At present 28,000 ton cargoes only can be handled in this area.

Rotterdam in the Netherlands is being considered as the site for construction of a pellet plant by a group of European steel companies. Reports indicate that to be economically worth while, the plant would have to have an initial capacity of 5 million tons rising to 20 million tons of pellets per year. In view of the requirement to handle 35-40 million tons of ore a year, Rotterdam is a logical site as the port can be developed to handle ships up to 130,000 tons and is connected by canal to most of the potential consumers.

Amsterdam was expected to be accessible to 100,000 ton carriers in 1965, following completion of dredging the North Sea Canal. Previously 40,000 ton carriers could reach the port and be unloaded at 6,000 tons per hour.

In October, 1964, a joint port venture by the city of Bremen and the Kloeckner company was opened. The new jetty was capable of berthing 2 x 30,000 ton or 1 x 70,000 ton carriers, and unloading at 2,000 tons per hour.

Le Havre in France could accept 60,000 ton carriers in 1964, discharging at 2,000 tons per hour.

Dredging of the Ghent-Terneuzen Canal from 41 to 44 feet was expected to be completed in 1966. Vessels of 50,000 d.w.t. will then be able to reach the new Sidmar steel plant which by 1968 is expected to require 2 million tons of iron ore per year. A discharging rate of 2,000 tons per hour is expected.

In 1964 it was reported that in Italy Cornigliano (Genoa) could discharge 60,000 ton vessels, Piombino 45,000 ton vessels and Taranto 60,000 ton vessels by 1965.

The port of Musel in Northern Spain will be capable of handling vessels of 80,000 d.w.t. when the modernization programme is completed. Coal and iron ore supplies for steel works in the Asturias are handled through this port.

Brazilian ore for Southern Europe is to be handled through the port of Bakar near Rijeka in Yugoslavia, which was reported in 1964 as being developed to take 100,000 ton carriers; a pelletizing plant is to be built at this port by the Brazilian ore producer and Yugoslavian port interests.

UNITED NATIONS STUDY

At the present time, Dr. N. H. Fisher, Assistant Director (Geology) of the Bureau is one of the Rapporteurs to the Steel Committee of the E.C.E. and the Committee for Industrial Development of the United Nations Organization who are preparing a report on the World Market for Iron Ore with the co-operation of the other regional committees of the United Nations.

However, drafting has not yet proceeded beyond the first sections of the report dealing with historical background and supplies of iron ore to individual countries. Sections still to be drafted include such topics as international trade in iron ore, development of iron ore prices, future evolution of iron ore consumption and production, probable patterns of trade in and consumption of iron ore.

The data so far available serve to confirm the views expressed regarding the ready availability of high grade ore and/or easily concentrated low grade ore in many parts of the world, particularly Canada, the United States, South America and, to a lesser extent, Africa.

It is expected that compilation of the report will be completed by July, 1966.

CONCLUSION - WHAT CAN AUSTRALIA EXPECT FROM THE WORLD MARKET FOR IRON ORE IN THE FUTURE?

There is no shortage of iron ore in the world today. Freight rates are tending lower as a result of the use of larger ships specially constructed so they can be used for oil or bulk cargoes such as iron ore. This means that competition in the iron ore trade will become more keen and widespread. The buyers market which has existed in recent years will continue into the future. New resources, particularly of low grade material easily converted to a high grade product of good structure for blast furnace use, will continue to be developed.

Prices obtained in recent long term fixed price contracts with Japan should be considered satisfactory in view of the normal Japanese practice of short term contracts with frequent revisions of price. Considering the large tonnages of ore in the Australian contracts it would have been unreasonable to expect prices to remain steady in what was already a buyers market for iron ore.

With establishment costs adequately covered by the recently concluded contracts with Japan, Australian producers will be able to maintain their share of the market in the future. Expansion into the European market may be possible, but even using the very large ore carriers that European ports are being developed to handle, the greater freight costs, as compared with ore hauled from countries bordering the Atlantic in similar sized ships, will require lower f.o.b. prices than the companies have been able to negotiate with Japan. One estimate suggests these may be of the order of 2/3 of the Japanese sale prices. However, there is no reason why such contracts should not provide a useful profit for the companies above their marginal production costs.

Competition in the European market may be intensified by development of low grade ores in the United States to supply pellets to domestic consumers. Some Canadian productive capacity may be taken up less rapidly by the United States consumers as a result, and outlets may well be found for this material in Europe at the expense of suppliers or potential suppliers from further afield such as Australia.

REFERENCES

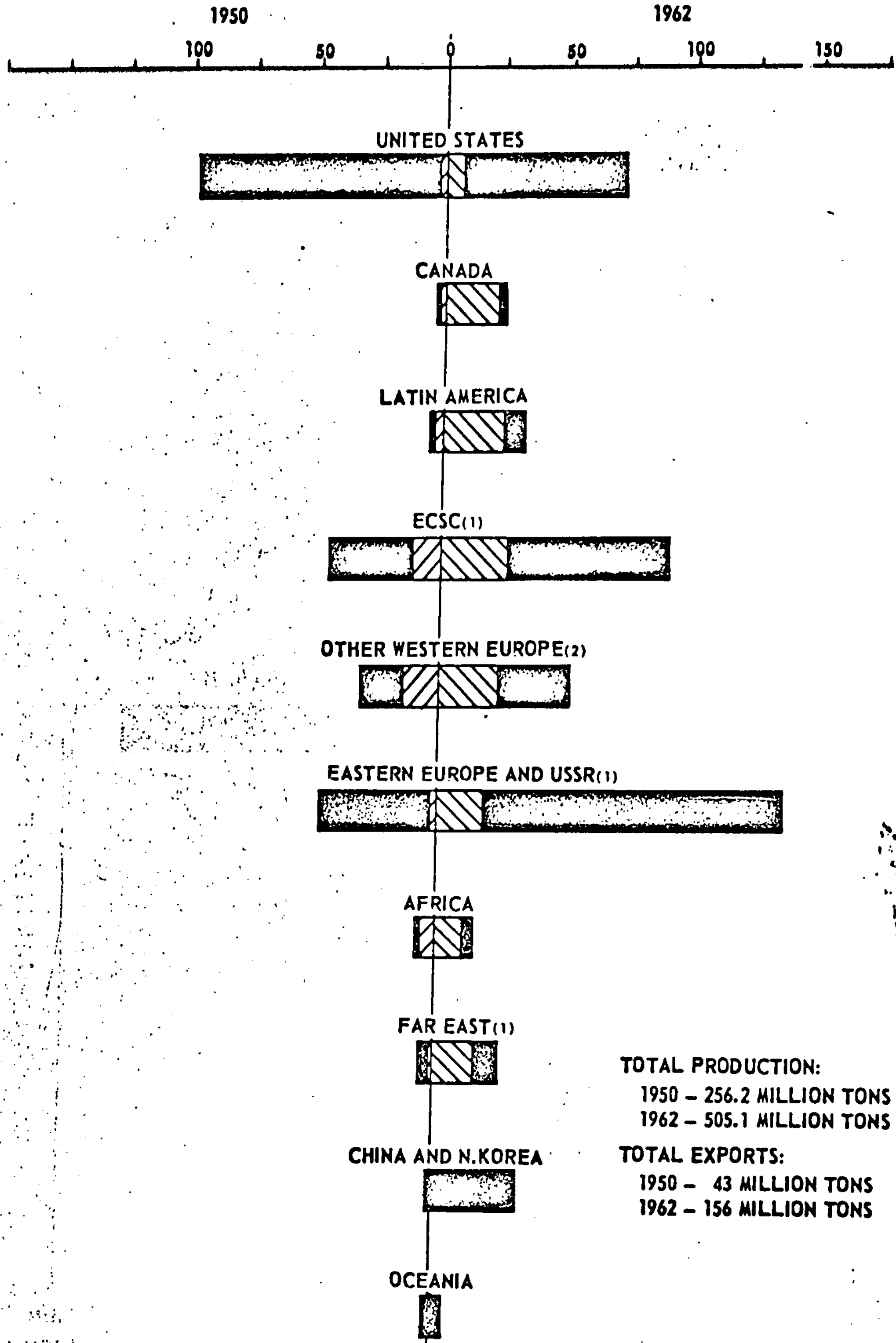
The principal reference is -

Elver, R. B., 1964 Economic Aspects of Iron Ore in a Changing Market. Mineral Information Bulletin MR74, Department of Mines and Technical Surveys: Ottawa.

Other information has been collected from Japan Metal News, Hamersley Iron Ore Briefs, Mineral Trade Notes, Report of the British Iron and Steel Institute's Visit to Japan, World Mining, Mining Congress Journal, Northern Miner, Steel Times, etc.

Information on iron ore reserves in the Appendix will be superseded by information in the United Nations Study when this is completed.

FIGURE 2
WORLD IRON ORE PRODUCTION AND EXPORTS, 1950 AND 1962
(MILLIONS OF LONG TONS)



(1) EXPORTS PRIMARILY TO COUNTRIES WITHIN THE GROUP.
(2) EXPORTS PRIMARILY TO ECSC AND COUNTRIES WITHIN THE GROUP.

Figure 2

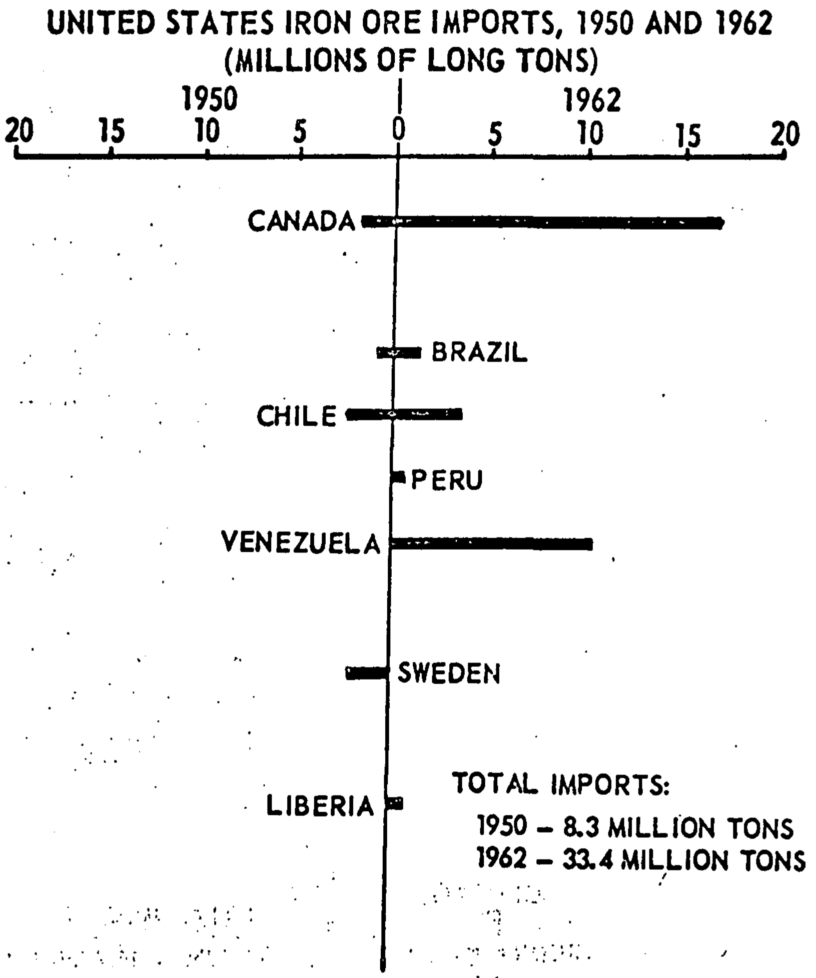

UNITED STATES IRON ORE IMPORTS, 1950 AND 1962
(MILLIONS OF LONG TONS)
1950
1962
20
15
10
5
0
5
10
15
20
CANADA
BRAZIL
CHILE
PERU
VENEZUELA
SWEDEN
LIBERIA
TOTAL IMPORTS:
1950 – 8.3 MILLION TONS
1962 – 33.4 MILLION TONS

Figure 3

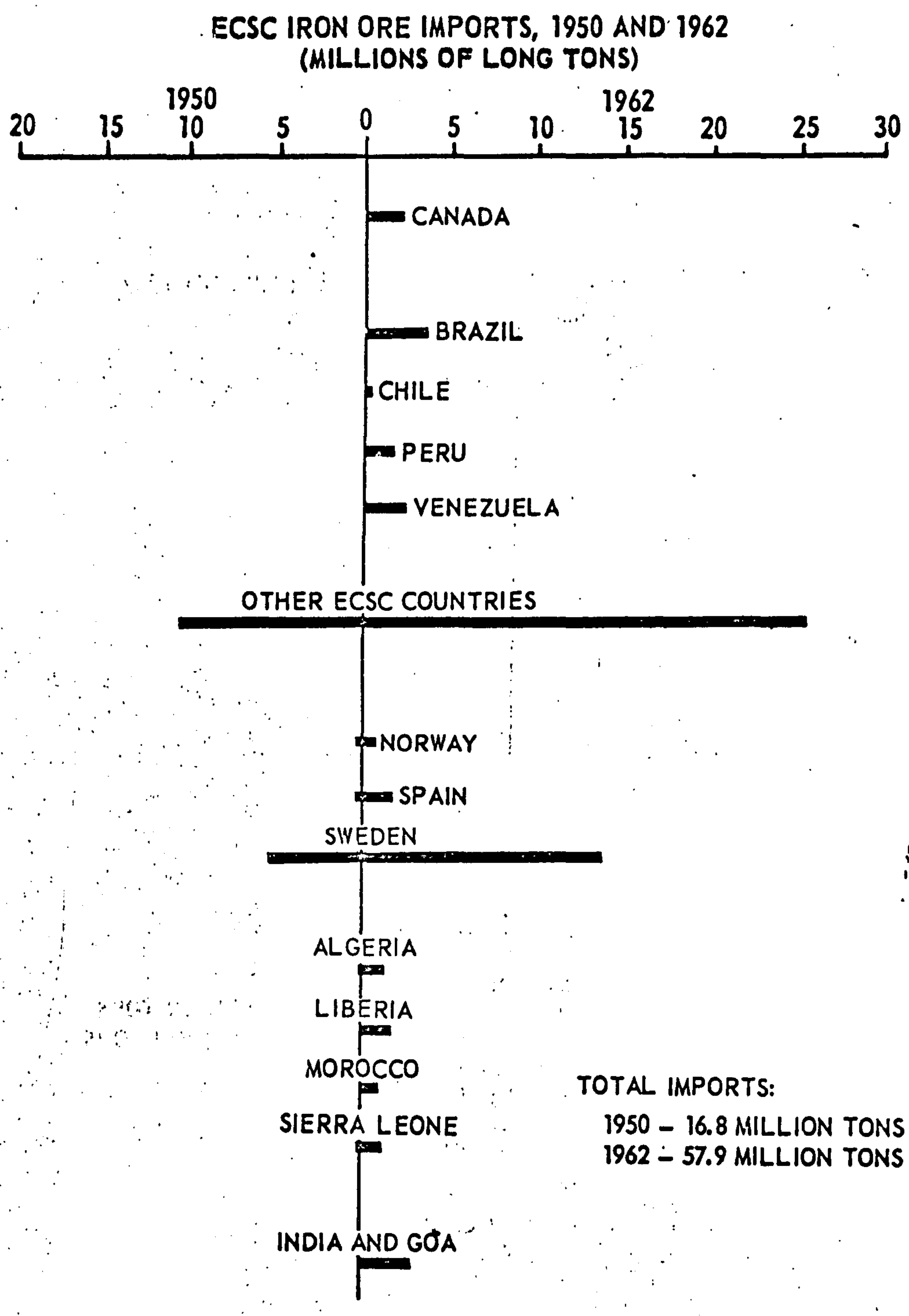

ECSC IRON ORE IMPORTS, 1950 AND 1962
(MILLIONS OF LONG TONS)
1950
1962
20
15
10
5
0
5
10
15
20
25
30
CANADA
BRAZIL
CHILE
PERU
VENEZUELA
OTHER ECSC COUNTRIES
NORWAY
SPAIN
SWEDEN
ALGERIA
LIBERIA
MOROCCO
SIERRA LEONE
INDIA AND GOA
TOTAL IMPORTS:
1950 – 16.8 MILLION TONS
1962 – 57.9 MILLION TONS

Figure 4

JAPANESE IRON ORE IMPORTS, 1950 AND 1962
(MILLIONS OF LONG TONS)

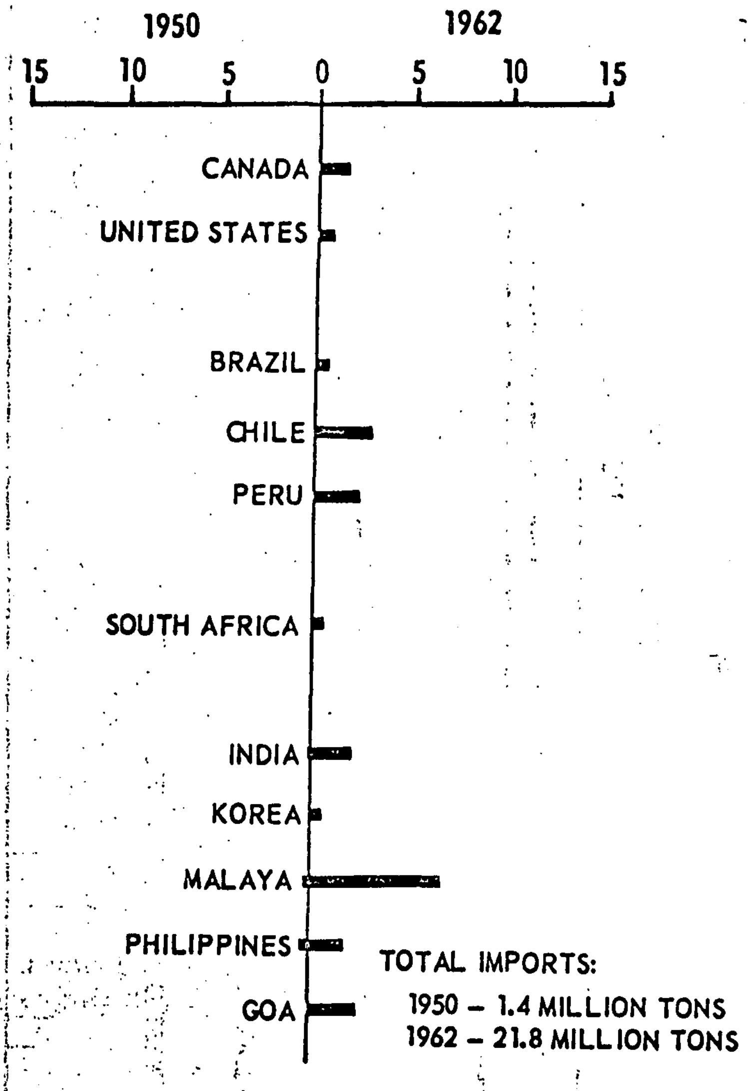


Figure 5

Figure 6

INDICES OF SELECTED IRON ORE PRICES
1956 = 100

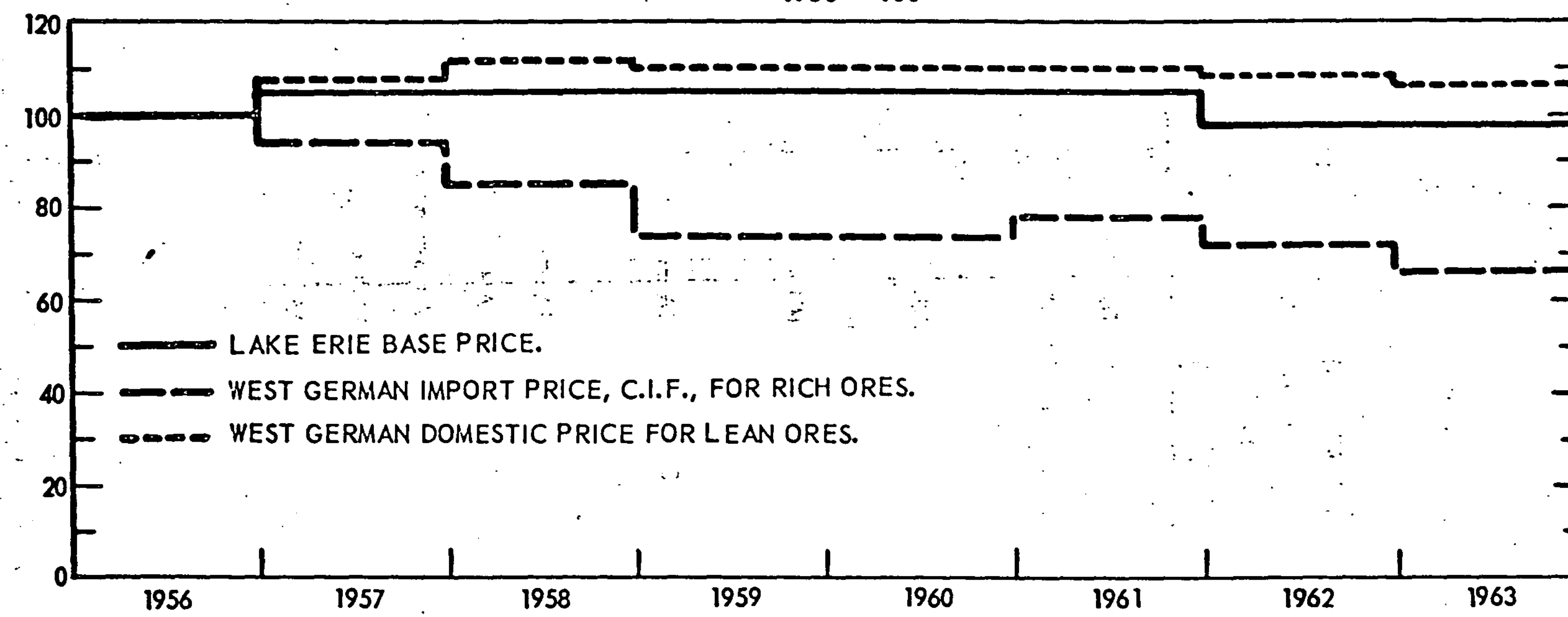


TABLE 1. IRON ORE CONTRACTS FINALIZED WITH JAPANESE STEEL MILLS DURING 1965. (EXCLUDING AUSTRALIAN CONTRACTS)

$ = US$

Contracted Company or Place of Origin	Product	Prices per Long Ton ($f.o.b.)	Prices per 1% Fe unit (US cents f.o.b.)	Price per Long Ton ($ c & f)	Price per 1% Fe unit (US cents c & f)	Approximate Date of Agreement	Contract (Million tons)	Delivery Period	Contract Years
The Indian Metals and	Iron ore 65% Fe	year 1 10.08	15.5	16.08 est.	24.7 est.	June 1965	7.36	July 1965	3
Trading Corporation	Basis for bulk of contract	year 2 10.01	15.4	16.01 est.	24.6 est.			July 1968	
Cuddalore	High grade 67% Fe	10.85	16.2	16.85 est.	25.1 est.	May 1965	0.85	1965-66	2
"	" " 65% Fe	10.64	16.4	16.64 est.	25.6 est.	" "	1.5	1965-67	3
V.S. Dempo	62/60% Fe	6.92	11.2	12.92 est.	20.8 est.	May 1965	0.70	1965	--
Salgaoncar	Lump 58/56% Fe	8.37	9.3	11.37 est.	19.6 est.	June 1965	0.05	1965	--
Itabira	Run of mine 66/64% Fe	8.00	12.3(a)	15.34	23.6 (a)	15.12.65	50.0	1966-67	15
	Fine 64/62% Fe	5.70	9.1(a)	13.08	20.8 (a)	(Date of price agree-			
	Gravel 66/64% Fe	7.20	11.1(a)	14.54	22.4 (a)	ment for 1966-67 shipments)			
	Tubarao-A 66/64% Fe	8.00	12.3(a)	15.34	23.6 (a)				
	Tubarao-B 66/64% Fe	8.20	12.6(a)	15.54	23.9 (a)				
	Pebble 66/64% Fe	8.50	13.1(a)	15.84	24.4 (a)				
Itabira	Run of mine 65% Fe	8.00	12.3	15.34 est.	23.6 est.	May 1965	1.0	1965-66	1
	Lump 68.5% Fe	10.15	14.8	17.49 est.	25.5 est				
	Pebble 66/67%	8.25	12.4	15.59 est.	23.4 est.				
Dungun	Lump 60/58% Fe	9.30	15.5	12.10 est.	20.2 est.	Nov. 1965	0.25	Mar-Oct. 1966	
	Sinter feed 58/56% Fe	6.40	11.0	9.20 est.	15.9 est.		0.75	" " "	
Tuago	60/57% Fe	8.00	13.3	10.80 est.	18.0 est.	Dec. 1965	0.04	1966	
Jurak	Lump 62/60% Fe	8.90	14.4	11.70 est.	18.9 est.	May 1965	0.22	1965	
Johore, M.M.C.	60/58% Fe	8.05	13.4	10.85 est.	18.1 est.	Dec. 1965	0.01 Spot basis	Jan-Feb. 1966	
Lembu	58/56% Fe	8.00	13.8	10.80 est.	18.6 est.	July 1965	0.40	1965-66	2
Dungun	Lump 60/58% Fe	9.45	15.8	12.25 est.	20.4 est.	March 1965	0.80	1965	1
	Haematite Sinter feed 60/58% Fe	6.75, 6.25	11.3, 104	9.55, 9.05 est.	15.9, 15.1 est.		0.61		
Kedah	58/56% Fe	8.00	13.8	10.80 est.	18.6 est.	May 1965	0.24	1965	
FEMCO	Lump ore 62/58% Fe	8.70	14.0	11.50 est.	18.5 est.	May 1961	0.21	1965	1
	Sinter feed 58/56% Fe	5.60	9.7	8.40 est.	14.5 est.		0.03	1965	1
Krivoi Rog	Sinter feed 60% Fe	4.32 est.	7.2 est.	11.52	19.2	Dec. 1965	0.02	Feb. 1966	
Hainan	55% Fe	7.07	12.9	9.87 est.	17.9 est.	27.12.65	0.1	1966	
Overseas Central Enterprise	58-60/58% Fe	9.70	16.4	14.20 est.	24.1	1965 and	0.43	1965	
Co (Nevada)	58-60/56% Fe	9.70	16.4	14.20 est.	24.1	end 1965	0.20	1965	

Table 1. continued

xporting ntry	Contracted Company or Place of Origin	Product	Price per Long Ton ($f.o.b.)	Price per 1% Fe Unit (US cents f.o.b.)	Price per Long Ton ($c & f)	Price per 1% Fe Unit (US cents c & f)	Approximate Date of agreement	Contract (Million tons)	Delivery Period	Contract Years
iberia	Liberian American	63% Fe	5.27 est.	8.4 est.	11.97	19.0	April 1965	0.16	1965	1
	Swedish Co.	Lump 20% / Sinter feed 80% — 63% Fe	5.27 est.	8.4 est.	11.97	19.0	April 1965	0.13-0.23/yr	1966-68	3
	"	65% Fe	6.05 est.	9.3 est.	12.55	19.3	January 1965	0.124 Spot basis	Jan-Mar 1965	--
ngola	Lobito	64/62% Fe	8.14	12.7	13.84 est.	21.3 est.	September 1965	5.1	1967-73	6
hile	Algorrobo	65% Fe	9.00	13.8	14.5 est.	22.3 est.	May 1965	1.8 Spot basis	1965	
	Bandrias	62/60% Fe					June 1965	4.0	Sept-1965-71	6
					14.50	23.8 (a)		0.25	1965	
			7.98	13.1(a)	14.25	23.4 (a)		0.85	1966-67	
			7.89	12.9 (a)	14.04	23.0 (a)		1.60	1968	
			7.86	12.9 (a)	13.92	22.8 (a)		1.30	1969-70	
uth Korea	Yangyang	Lump 65% Fe	8.70-9.20 est.	13.4-14.2 est.	11.50-12.00	17.7-18.5	May 1965	0.06	1965	1
		Sinter feed 60%						0.06		
hilippines	Sibuguey	Lump 55/53% Fe	9.10	16.5	11.90 est.	21.6 est.	June 1965	0.24	1965	1
		Sinter feed 55%	8.30	15.1	11.10 est.	20.2 est.		0.20		

(a) As reported; calculated at mid-point of grade range

TABLE 2. RECENTLY COMPLETED PELLET CONTRACTS (1964) WITH JAPANESE STEEL MILLS

$ = US $

Exporting Country	Contracted Company or Place of Origin	Product	Prices per Long Ton ($ f.o.b.)	Prices per 1% Fe Unit (US cents f.o.b.)	Prices per Long Ton ($ c & f)	Price per 1% Fe Unit (US cents c & f)	Approximate Date of Agreement	Contract (Million tons)	Delivery Period	Years
Peru	Marcona	Pellets 66.5/65% Fe	13.27 est.	20.0 est.	17.42	26.2	May 1964	1.05	1964-65	1
			11.96 est.	18.0 est.	16.11	24.2		5.00	1966-70	
Goa	Chowgule & Co., Pale	Pellets 66% Fe	10.45 est.	15.8 est.	16.45	24.92 Renewal after 3 yrs.	May 1964	3.30	1966-71	6
U.S.A.	Kaiser Steel Corp.	Pellets 65/64% Fe	11.63 est.	17.9 est.	16.13	24.8 Renewal after 3 yrs.	January 1964	11.34	1966-71	6

TABLE 3. AUSTRALIAN IRON ORE CONTRACTS WITH JAPANESE STEEL MILLS

AT 1st FEBRUARY, 1966

$ - US $

Operating Company	Product	Price per Long Tons ($ f.o.b.)	Price per 1% Fe unit (US cents f.o.b.)	Price per Long Ton ($ c & f)	Price per 1% Fe Unit (US cents c & f)	Contract (Million tons)	Delivery Period	Contract Years
Western Mining Joint Venture	Lump ore 60% Fe	8.45 est.	14.1 est.	12.60	21.0	5.1	1966-73	8
Cliffs Western Australian Mining Co. Pty. Ltd.	Pellets 64% Fe	12.224	19.1	14.624 est.	22.9 est.	71.4	1968-89	21
Hamersley Iron Pty. Ltd.	Lump ore 64% Fe	9.92 30 x Gmm	15.5	12.16 est.	19.0 est.	85.5	1966-81	16
		9.664 100 x Gmm						
		7.68 Fines						
	Low grade 53-60% Fe	4.50-6.0	8.5-10.0	6.90-8.40 est.	13.0-14.0 est.	5.0	1967-79	12½
	Pellets 63% Fe	11.6555	18.5	14.0555 est.	22.3 est.	16.0	1968-83	16
Mt. Newman Iron Ore Co. Ltd.	Lump 64% Fe	9.37 30 x Gmm	14.6	12.22 est.	19.1 est.	100.0	1969-90	22
		9.16 100 x Gmm						
		7.48 Fines						
Goldsworthy Mining Pty. Ltd.	Lump 64% Fe	9.856	15.4	12.856 est.	20.1 est.	18.5	1966-72	7
Francis Creek Iron Mining Corporation Pty. Ltd.	Lump 62% Fe	8.90	14.4			3.0	1966-73	8
Dargan Mining and Industrial Co. Pty. Ltd.	Lump 63% Fe	9.10	14.4			1.4	1966-73	7
Savage River Consortium	Pellets 67.5% Fe	50% at Production Cost				45.0	1967-85	20
		50% at World Price					1968-68	
		13.50	20.0	16.80 est.	24.9 est.			
		12.83	19.0	16.13 est.	23.8 est.		1969-71	
		12.49	18.5	15.79 est.	23.5 est.		1972-74	

APPENDIX

Iron Ore Reserves - Extracts from United Nations publication:

"Proceedings of the United Nations Interregional Symposium on the Application of Modern Technical Practices in the Iron and Steel Industry to Developing Countries".

Prague - Geneva / November 1963.

II. DISCUSSION PAPERS

RAW MATERIALS IN AFRICA FOR IRON AND STEEL MANUFACTURE

(DOCUMENT ECA.1)[1]

Introduction

The primary raw material for the manufacture of all iron and steel products is pig iron, which is produced from iron ore, coke and limestone flux. Iron ore may be partly replaced by scrap iron which in turn is ultimately derived from iron ore. It may be stated in rough figures that every ton of iron requires one ton of coal and half a ton of limestone. More than half the coal can be eliminated by electric smelting methods which use approximately 2,000-2,500 kWh per ton of pig-iron produced. Coal can occasionally be replaced by other forms of carbon e.g., natural gas or charcoal. Pig-iron for steel production requires varying quantities of manganese and the corresponding amount of ore is added to the furnace charge. Refractories are needed for the construction or lining of furnaces. Silica linings may be employed with an acid steel-making process whilst magnetic or dolomite refractories are used with the more common basic process.

This study intentionally omits two important constituents of iron and steel manufacture: water and electricity.

Water is admittedly a vital raw material since it takes 5-10 cu. m. of added water to produce one ton of steel. This represents 2½-3 per cent of the total circulating load. Any of the other raw materials can be transported over long distances from foreign sources to a viable steel industry as is the case in Italy, but water has to be in plentiful supply at the site. Inventories of surface and underground water resources were considered to be outside the scope of this study.

[1] Paper prepared by the secretariat of the Economic Commission for Africa. See page 121 for discussion.

Electricity is not usually named a natural resource unless it derives from water power. While an iron and steel industry would benefit from cheap hydroelectric power, this is not an essential condition. Some of the leading steel industries in the world, e.g., the United States, Great Britain and Germany, were developed without hydroelectric power. It was therefore decided to exclude actual and potential supplies of electric water power from the present study.

This report represents an up-to-date inventory for Africa of the mineral substances mentioned above. Each material has been treated under a separate heading. For purposes of presentation the countries have been listed under the following sub-regional groupings:

NORTH AFRICA

Morocco, Rio de Oro, Algeria, Tunisia, Libya, UAR (Egypt).

EAST AFRICA

Sudan, Ethiopia, Somalia, Kenya, Uganda, Rwanda, Burundi, Tanganyika, Nyasaland, Northern Rhodesia, Southern Rhodesia.

CENTRAL AFRICA

Cameroon, Chad, Central African Republic, Congo (Brazzaville), Gabon, Congo (Leopoldville).

WEST AFRICA

Niger, Nigeria, Dahomey, Togo, Ghana, Ivory Coast, Liberia, Sierra Leone, Guinea, Senegal, Mauritania, Mali, Upper Volta.

SOUTHERN AFRICA

Madagascar, Mozambique, Bechuanaland, Basutoland, Swaziland, South Africa, South West Africa, Angola.

Summary of iron-ore production and reserves in Africa
(Million tons)

The mineral deposits have been divided into three groups:

(*a*) Recognized and in production;

(*b*) Recognized deposits for which production plans have been or are being drawn up;

(*c*) Deposits where no extraction is envisaged at present and which are not necessarily of economic interest.

		Reserve tonnages		
	1962 production	(*a*)	(*b*)	(*c*)
SUB-REGION:				
North	4.43	237	220	2,374
East	0.64	102	100	653
Central	0.01	—	860	370
West	6.73	1,539	1,404	1,283
Southern	4.83	253	400	6,843
	16.61	2,131	2,984	11,523

Summary of iron-ore production and reserves in Africa *(continued)*

	1962 production	Reserve tonnages (a)	(b)	(c)
BY SUB-REGIONS				
North Africa				
Morocco	1.15	50	20	149
Rio de Oro	—	—	—	20
Algeria	2.06	140	—	995
Tunisia	0.76	27	—	30
Libya	—	—	—	1,100
UAR (Egypt)	0.46	20	200	80
TOTAL, North Africa	4.43	237	220	2,374
East Africa				
Sudan	0.02	12	—	39
Ethiopia	—	—	—	8
Somalia	—	—	—	100
Kenya	—	—	—	27
Uganda	—	—	—	10
Tanganyika	—	—	—	121
Northern Rhodesia	—	—	—	300
Southern Rhodesia	0.62	90	100	47
TOTAL, East Africa	0.64	102	100	653
Central Africa				
Cameroon	—	—	—	120
Central African Republic	—	—	—	—
Congo (Brazzaville)	—	—	—	—
Gabon	—	—	860	150
Congo (Leopoldville)	0.01	n. a.	n. a.	100?
TOTAL, Central Africa	0.01	—	860	370
West Africa				
Niger	—	—	—	96
Nigeria	—	—	30	60
Dahomey	—	—	—	250
Togo	—	—	—	42
Ghana	—	—	—	1
Ivory Coast	—	—	—	344
Liberia	3.60	289	424	—
Sierra Leone	1.90*	100	—	100
Guinea	0.45	1,000	950	20
Senegal	—	—	—	125
Mauritania	0.78	150	—	185
Mali	—	—	—	10
Upper Volta	—	—	—	50
TOTAL, West Africa	6.73	1,539	1,404	1,283
Southern Africa				
Madagascar	—	—	—	250
Mozambique	—	—	—	53
Swaziland	—	43	—	240
South Africa	4.33	200	400	6,000
South West Africa	—	—	—	300
Angola	0.50	10	n. a.	n. a.
TOTAL, Southern Africa	4.83	253	400	6,843

Iron ore

North Africa

Morocco

This country produced 1.15 million tons of iron ore in 1962.

The most important known deposit is Uixan in northern Morocco, which accounts for two-thirds of the current output. The ore is hematite averaging 62 per cent iron with a low content of phosphorus and silica. The Setolazar deposit is in the immediate vicinity of Uixan; the ore is pyritic hematite and magnetite of 51 per cent Fe, and is mined by underground methods. The ore reserves of the Uixan-Setolazar deposit are 50 million tons.

The Ait Amar mine is Morocco's third producer. The deposit is 150 km west of Casablanca and contains siliceous low grade ore with a fairly high phosphorus content. The remaining reserves of 30 million tons will have to be extracted by underground workings.

Several known deposits have been studied with a view to future exploitation. The most promising is Khenifra between Meknès and Marrakech: proved underground reserves are 27 million tons and an additional 32 million may be considered as potential. The ore is goethite averaging 43 per cent Fe with 10 per cent SiO_2 and a high barytes content. Attempts to upgrade the ore have met with partial success.

The following other deposits are also under study:

Tachilla-Ouarzemine	10-20 million tons, 40-45% Fe
Imi-N-Tourza	40 million tons, 50-52% Fe
Keradid	25 million tons, 40% Fe
Ait-Ahmane	10 million tons, 46% Fe

Rio de Oro (Spanish Sahara)

A titaniferous iron ore occurrence has recently been discovered at Agracha. The orebody has been drilled and sampled, and the tonnage is estimated at 20 million with a 54 per cent iron content.

Algeria

Algeria has been a substantial iron ore producer for many years.

The 1962 production was just over 2 million tons, all of which was exported. The various mines have an annual capacity of 4 million tons but the actual output is governed by sales outlets. The most important deposits are those of Quenza-Boukhadra with a proven reserve of 130 million tons of hematite ore, assaying 54 per cent Fe and 3 per cent SiO_2. Five other deposits have a total of about 10 million tons of ore reserves.

A substantial deposit of oolitic iron ore has been studied at Gara Djebilet near Tindouf in south-west Algeria. The probed tonnage established in 1961 represents 765 million of 57.5-58.3 per cent Fe. The probable and possible reserves total an additional 230 million tons with on avarage Fe content of 57+ per cent. The ore is principally magnetite which lends itself to dry magnetic concentration; the first trials have indicated a possible shipping product of 60+ per cent Fe.

The phosphorus and titanium contents are fairly high: 0.8 per cent P and 0.3 per cent TiO_2.

Libya

The only known deposit is the oolitic ironstone of the Shatti Valley in Fezzan Province. It is a mixture of hematite and goethite with high phosphorus and silica contents. A provisional estimate of tonnage and grade is as follows:

From 700 million at 48% Fe, 0.26% P and 17% SiO_2;

To 1,400 million at 42% Fe, 0.35% P and 27% SiO_2.

Tunisia

The main deposit is Djerissa which accounted for over 700,000 tons of the total of 760,000 tons of iron ore produced in 1962. The ore is hematite of 54 per cent Fe with a low silica and phosphorus content. The reserves are estimated at 15 million tons. The other producer is Tamera with reserves of 12 million tons assaying 49-52 per cent Fe and a little arsenic.

The oolitic ironstone of Djebel Ank is being explored at present. It is believed to represent 30 million tons at 53 per cent Fe.

UAR (Egypt)

Up to the present, the entire Egyptian production, which in 1962 amounted to 459,500 tons, has come from the Aswan deposit in Upper Egypt. The ore is oolitic hematite of 44 per cent Fe and 14 per cent SiO_2; the reserves are 20 million tons.

Another known deposit is located in the Eastern Desert. The ore is of the Lake Superior type, highly siliceous and assaying 43 per cent Fe; the total available tonnage is estimated at eighty million tons.

Present planning calls for the Baharya project to go into production in 1966. The deposit is located in the oasis of the same name, some 300 km south-west of Cairo. The estimated reserves are around 200 million tons of goethite with an Fe content of 50 per cent and about 10 per cent of manganese.

Egypt's iron ore production is scheduled to reach 1.2 million tpy in 1966 and 3 million tpy by 1970.

East Africa

Sudan

The most important iron ore deposits are those of Sofia and of Abu Tulu. The first produced 20,000 tons in 1962 from a deposit containing 12 million tons of magnetite with a 60 per cent Fe content and is scheduled to produce 100,000 tons of ore per year in the near future. The reserves at Abu Tulu are estimated at thirty-six million tons of magnetite with a grade of 61 per cent Fe.

Three smaller deposits have a total tonnage of 3 million of hematite with a +60 per cent iron content: amongst these is the Fodikwan deposit near the Red Sea which is to be exploited at the rate of 100,000 tons per year.

Ethiopia

The Agametta deposit in Eritrea has been considered a potential mining project for many years. The ore is magnetite of 60 per cent Fe and the probable reserves are around 3 million tons.

Another small deposit is being explored at present: it is at Yubdo in western Ethiopia. The tonnage has not yet been determined, but appears to be of the order of 5 million tons of magnetite assaying 60 per cent Fe.

Somalia

An ironstone occurrence to the west of Mogadiscio has not been explored to date as it is of doubtful value. A possible 100 million tons at 50 per cent Fe have been estimated.

Kenya

Deposits of iron ore have been prospected but are probably too small for production purposes. A pyritic lode at Bukara is estimated to contain 17 million tons. The hematite orebody at Homa mountain has an estimated tonnage of 10 million to a depth of thirty metres.

Uganda

The Tororo magnetite deposit has 10 million tons of proved reserves averaging 65 per cent Fe and 1 per cent P.

Tanganyika

The Liganga titaniferous magnetite deposits in southern Tanganyika were drilled in 1956-1957. The indicated tonnage is 45 million averaging 49 per cent Fe and 13 per cent TiO_2.

CENTRAL AFRICA

Cameroon

The deposit known as Les Mamelles is located in the coastal area, 40 km south of Kribi. The deposit forms part of a small mountain range, 7 to 8 km long and 200-300 m above the surroundings. The ore is a ferruginous quartzite. The reserve tonnage is estimated at 120 million of 33 per cent Fe.

Central African Republic

The Damara deposit is the only known occurrence of possible economic interest; it is a mixture of magnetite and hematite which was studied in detail in 1962. Iron ore formations have been reported in other parts of the country, e.g., in the M'Bari river basin and near Roandui, and might be prospected at a later date.

Congo (Brazzaville)

Iron ore outcrops in the north-west indicate possible extentions into Congolese territory of the Mekambo deposit in Gabon territory. There is also a good chance of the Tchibanga deposit in south-east Gabon extending across the border into the Mayombe district and this is being investigated. The Zamaga ironstone outcrop which was given much publicity recently is unlikely to be of real economic importance.

Gabon

The Mekambo deposit in eastern Gabon ranks amongst the most important in the world. It consists of a number of iron-bearing mountain ranges only three of whic[h] have been explored to date. The Boka-Boka's reserve[s] are around 190 million tons of hematite, the Beling tonnage is estimated at 570 million and the Batoual at 100 million. The average over-all grade is reporte[d] as 62.24 per cent iron. A transportation study is bein[g] carried out at present by the International Bank, an[d] Mekambo is likely to become the biggest single iron o[re] producer in Africa in a few years' time.

The Tchibanga deposit has been known for ma[ny] years since it is located only 80 km from the coast [in] southern Gabon. The proved reserves are 126 millio[n] tons averaging 40-45 per cent Fe but most of the o[re] does not lend itself to upgrading.

The Mebanga-N'Gama iron ore formations in northe[rn] Gabon near Mitzic are being explored at present. T[he] Mebaga mountain has an indicated tonnage of 20 milli[on] of ferruginous quartzite with an iron content arou[nd] 60 per cent. Similar conditions are found in the N'Ga[ma] range, 15 km to the south, on which information is n[ot] yet available.

Another deposit of titaniferous magnetite is at Hund[i] in the eastern region. The possible reserves are 8 milli[on] tons at about 40 per cent Fe and 6 per cent TiO_2.

The banded ironstone deposit at Manyoro on La[ke] Tanganyika has not yet been closely examined. Estima[tes] speak of a possible tonnage of 68 million at about 30 [per] cent Fe.

Northern Rhodesia

The total possible reserves are of the order [of] 300 million tons. The most important deposit is [at] Nambala, west of Lusaka. A conservative estim[ate] indicated about 180 million tons of breccia type [ore] averaging 57 per cent iron and 18 per cent silica, a[nd] 10 to 50 million tons of shale replacement ore with 62 [per] cent iron and 9 per cent silica.

Several smaller replacement deposits are known in [the] Sanje area near Lusaka. The total reserves are ab[out] 25 million tons of hematite ore varying from 57 per c[ent] to 69 per cent Fe, low in silica but with some phospho[rus]. Sedimentary ironstone formations occur around Lusa[ka]. The most important is Nagaibwa with 27 million ton[s] 50-60 per cent iron and 15-20 per cent silica: the depo[sits] at Pamba and Chongwe total 20 million tons of magne[tite] and specular hematite ore with a 60 per cent iron cont[ent].

The Kambumba orebody near Broken Hill cont[ains] hematite, magnetite and manganese. It is of the repl[ace]ment type and has a tonnage of 33 million avera[ging] 40 per cent iron and 18 per cent manganese.

Southern Rhodesia

The total proved and possible reserves of iron [ore] (mainly hematite) exceeding 55 per cent Fe are aro[und] 90 million metric tons. These are located in the Salisb[ury] area and to the south of it.

The Bukwa area in the Bulawayo district has b[een] partly drilled and the possible reserves are of the o[rder] of 100 million tons of high-grade ore containing u[p to] 65 per cent Fe. Several substantial deposits are loc[ated] between Salisbury and Que Que: amongst these are Amyuma, Chikurubi and the Que Que deposit itself.

The Mongula and Manyoka deposits near the Mozambique border are estimated to contain 10 million tons at +60 per cent Fe and a further 37 million at 30-45 per cent Fe.

Iron ore production in Southern Rhodesia was 618,614 metric tons in 1962, most of which was used for the production of iron and steel for the home market and for export.

The Monts Bilan range is located 40 km north-east of Kango and also forms part of the present prospecting campaign in this area. The ore has a very high silica content with an average of 33 per cent. The iron content is estimated at 45 per cent Fe. Several million tons of ore are indicated.

Congo (Leopoldville)

Iron ore deposits are known at Ituri in the Oriental Province, in South Katanga, in Maniema and in Kasai. The Ituri orebody is hematite ore with a 65 per cent Fe content. The other deposits average from 50 to 69 per cent iron. The orebodies have not yet been closely examined since their geographical location made them unlikely producers for export. The reserve tonnages are estimated at 10-50 million per deposit.

A small production is being maintained in South Kasai to serve the copper industry: the output in 1962 was 5,947 tons averaging 55 per cent Fe.

West Africa

Niger

The ironstone formation in the Niger basin south of Niamey has been studied in recent years. It is an oolitic goethite deposit which outcrops on the river banks. The ore is siliceous, high in phosphorus, with an iron content varying from 42-50 per cent. It does not lend itself to upgrading. The workable reserves are estimated at 16 million tons of 49 per cent Fe around Say and 80 million tons of 42 per cent Fe on the adjacent Kolo plateau.

Nigeria

Two main deposits are known and have been explored: Agbaja near Lokoja in the Northern Region is an oolitic deposit of twenty-four-feet thickness with an overburden of twenty feet of cemented laterite. The proved reserves of a portion of the deposit amount to about 30 million tons with 48 per cent Fe, 0.8 per cent P and 7 per cent SiO_2.

Enugu in the Eastern Region is a laterite deposit with a low grade iron content. The reserve of unscreened ore amounts to about 60 million tons of 32 per cent Fe. The ore can be upgraded by screening off fractions below 1/8" but this decreases the reserves to 20 million with an average content of 40 per cent Fe, 0.2 per cent P, 20 per cent SiO_2 and 0.8 per cent TiO_2.

There is no iron ore production in Nigeria at present but the Federal Government is planning an integrated iron and steel plant to utilize local raw materials. The mill is scheduled to move on stream by 1970.

Dahomey

Oolitic ironstone outcrops occur along the Niger in the north of the country. The mineral is goethite and assays around 50 per cent Fe, 0.8 per cent P and 7.25 per cent SiO_2. The Kandi iron ore deposit contains workable reserves of 250 million tons and may be considered an extension of the Say-Tamou deposit located eighty miles to the north in the Niger Republic.

Togo

The iron ore deposit at Banjeli in northern Togo was prospected from 1954-1956. The reserves are estimated at 42 million tons of highly siliceous ore of which 12 million average 48 per cent Fe whilst the other 30 million tons have an iron content of only 35 per cent.

Ghana

The only known occurrence is near Sheine in the northern region: about one million tons are available with an iron content averaging 46-51 per cent.

Ivory Coast

Iron ore mineralization has been prospected near the western border. A substantial low-grade deposit of itabirite is located on the eastern slopes of the Nimba range. In the vicinity of Guiglio, the Gao mountain is believed to contain some 150 million tons of magnetite ore averaging 42 per cent Fe.

A sedimentary ironstone deposit is known at Sassandra on the coast, west of Abidjan. The oolitic type ore forms a layer of 2 to 6 m thickness below an overburden of clay, 1-2 m deep. The reserves are estimated at 194 million tons averaging 40 per cent Fe.

Liberia

There are four principal iron-ore deposits:

(1) Bomi Hill. In 1962 the Liberia Mining Co. produced the following types of ore:

Open-hearth	697,000 tons 66.5% Fe, 0.1% P, 4.0% SiO_2
Blast furnace. . . .	742,000 tons 62.6% Fe, 0.12% P, 4.7% SiO_2
Fines	331,000 tons 62.0% Fe, 0.12% P, 5.8% SiO_2
Concentrates . . .	1,376,000 tons 64.0% Fe, 0.08% P, 0.2% SiO_2
	3,146,000 metric tons

(2) Mano River. The deposits contain two types of ore, siliceous and aluminiferous, both with an average Fe content of 56 per cent. Extraction started in December 1961: the following tonnages were produced up to 31 March 1963:

Crude ore	1,852,000 mt
Concentrates	1,143,000 mt

(3) Nimba. Production is scheduled for the second half of 1963 at an initial rate of six million tpy. The ore is a mixture of martite and goethite with an average Fe content of 65 per cent.

(4) Bong. Production and export are due to start in 1965. The mineral is itabirite and the run of mine ore averages 37.5 per cent Fe and 42.0 per cent SiO_2. The

project calls for concentration into a shipping product with 65.0 per cent Fe, 6.5 per cent SiO_2, 0.05 per cent P and 0.02 per cent S.

SUMMARY OF LIBERIAN IRON ORE RESERVES IN MILLION METRIC TONS AS OF 1 APRIL 1963

	Proven	Probable	Total
Bomi Hill	42	8	50
Mano River	20	26	46
Nimba	227	86	313
Bong	269	35	304
	558	155	713

The Liberian authorities expect an annual production rate of 19-21 million tons when all the mines are in full operation.

Sierra Leone

The Marampa deposit has an estimated tonnage of 100 million. The ore is hematite averaging 48 per cent Fe which can be upgraded to 65 per cent. The annual production for 1962 was 1.9 million tons of concentrates.

The Tonkolili deposit is also substantial but unlikely to be developed in the near future. Its estimated reserves are in excess of 100 million tons of magnetite and hematite with an Fe content of 56 per cent.

Guinea

The Conakry deposit has been worked since 1953. It covers practically the entire peninsula of Kaloum which extends over 35 km with a width of 1 to 6 km between Conakry and the mainland. The lateritic ore is divided into two layers: the upper is 8 to 10 m deep and consists of hard, compact mineral which averages 51.5 per cent Fe, 0.06 per cent P, 0.10 per cent S and 12.1 per cent H_2O. This ore is divided into two types depending on whether the chromium content is below or above 1.2 per cent. The bottom layer is 8 to 25 m deep and consists of soft light ore containing 56 per cent Fe, 0.5-0.6 per cent Cr and 0.3-0.4 per cent Ni. Present production is confined to the hard ore at an annual rate of around 500,000 tons. Because of its chromium content the demand for this type of ore is limited.

To date only one-third of the deposit adjoining Conakry has been fully explored. The total reserves of the Kaloum peninsula are of the order of 1,000 million tons.

The Kade deposit in north-western Guinea is a fine-grained sedimentary orebody with indicated reserves of fifteen to twenty million tons. The Fe content is not known.

The Yomboieli deposit is located 110 km east of Conakry in the Marampa formation which is adjoining Sierre Leone and encloses the deposit of the same name. The reserves at Yomboieli are estimated at 4.5 million tons with an average Fe content of 46 per cent.

The Nimba-Simandou deposits near the Liberian border contain a considerable tonnage of high grade ore. Reserves of 250 million tons have been reported at Nimba and 700 million tons at Simandou. In both locations the ore is hematite containing more than 65 per cent Fe. A 200-million-dollar project has been drawn up and initial production is scheduled for 1966.

Senegal

The only known deposit is at Saraya on the western bank of the Faleme River, some 800 km from the coast. The reserves are estimated at eighty million tons of martite and magnetite averaging 60 per cent Fe. There are an additional forty-five million tons of lower grade material of 53-54 per cent Fe which can be upgraded to 58-59 per cent.

Mauritania

Port Gouraud occupies a leading place amongst the high-grade iron ore producers of the world. The Kédia Idjil mountain range is 25 km long and 10 km wide. Massive quartzite outcrops on the eastern and northern flanks of the range and some ten major concentrations of hematite of +60 per cent Fe occur along this outcrop. It is estimated that 150 million tons can be extracted by open pit methods. Two of the deposits, Tazadit and Fderik, are being exploited at present. Their reserves are 90 million and 27 million tons respectively, averaging 65.5 per cent Fe, 0.04 per cent P and 0.0025 per cent S.

In 1962 785,000 tons were extracted and stock-piled at the mine. The first shipment to Port Etienne on the 650 km railroad occurred in June 1963.

The annual production target is 1.8 million tons for 1963 and 4.5 million tons as from 1964. A production rate of 6 million tpy is scheduled after 1966.

Three possible sources of iron ore are known in the region of Akjoujit:

(*a*) The copper project of Guelb Moghein could yield some 10 million tons of magnetite concentrates averaging 67-68 per cent as a by-product from the treatment of the oxide and sulphide copper minerals.

(*b*) The hematite deposit of Legheilat El Kader has reserves of fifteen million tons assaying 52-53 per cent Fe, 0.13 per cent P and 0.9 per cent Mn. The mineralized surface lenses have a thickness of 10 to 20 m.

(*c*) Quartz-magnetite outcrops form the crest of a 100 km range south of Akjoujit. The ore in sight is estimated at 160 million tons averaging 40 to 50 per cent Fe.

Mali

A limestone replacement deposit has been prospected at Nioro in western Mali. The total tonnage is estimated at 10 million tons of magnetite with an iron content of 63 per cent Fe.

Upper Volta

The titaniferous magnetite deposit of Tin Edia is located some 250 km north-east of the capital, Ouagadougou. A possible tonnage of fifty million has been estimated, averaging 52-54 per cent Fe and 7-15 per cent TiO_2.

SOUTHERN AFRICA

Madagascar

Several deposits have been studied in recent years with a view to establishing an iron and steel industry on the island.

Fasintsara is located in the eastern coastal range, 90 km west of the port of Mananjary. There is a substantial tonnage of ferruginous quartzite ore 20-45 m thick, but the iron content is low and decreases in depth. Some 30 million tons of 36 per cent ore are at the surface and a further 15 million of 34 per cent are from 100-200 m below the surface.

A little further to the south and 120 km from Fianarantsoa is the deposit of Bekisopa. The mineralization consists of magnetite veins and lenses in a small mountain range. A recent study indicates 10 million tons of 60 per cent Fe and an additional 60 million averaging 30-35 per cent Fe.

The Moramanga deposit is favourably located 90 km from Tananarive and close to the railroad leading to the coast. It is a lateritic deposit with an important content of nickel, chromium and titanium (1.5-2.1 per cent). The estimated reserves are 38 million tons averaging 46 per cent Fe.

Betioky is only 40 km from the Sakoa coalfield in south-eastern Madagascar. The ore is a low grade mixture of limonite and hematite. It is easily crushed and might lend itself to electro magnetic concentration. The probable reserves are estimated at 10 million tons of 28 per cent Fe: an additional 20 to 30 million tons are considered possible.

Mozambique

The Machedua orebody in the Tete district has been computed at 50 million tons. The mineral is titaniferous magnetite averaging 50 per cent iron, 18 per cent TiO_2 and 0.7 per cent vanadium.

A recent aeromagnetic survey of the Fingoe region confirmed some known magnetite deposits and led to the discovery of others. The total tonnage of the orebodies already discovered is estimated at 3 million tons.

Bechuanaland

A high-grade iron ore deposit occurs at Bikukunuru, some 30 km south-east of Serowe. The deposit consists of two low hills and is associated with limestone. The orebody is mainly massive hematite with a 64 per cent iron content. The reserve tonnage has been provisionally estimated at 250,000 tons but the extension of the orebody in depth is at present unknown. A similar iron ore occurrence is located 80 km further south where a layer of banded magnetite of 1.0 to 1.5 m thickness has been traced for some 5 km.

Swaziland

The Ngwenya deposit, previously known as Bomvu Ridge, lies 50 km north-west of Mbabane. The ore is of sedimentary origin, hematite in banded ironstone. The two constituent orebodies have been closely explored and the following probable reserves established:

Castle Block	31.6 million tons at 62.6% Fe plus 450,000 tons float ore at 64.3%
Lion Block	11.0 million tons at 61.1% plus 100,000 tons float ore at 62.6%

The ore also contains 0.4 per cent manganese and 4.2 per cent silica.

Preparations for mining the deposit are well advanced: the initial production rate is set at 720,000 tpy and this is to be stepped up to 1.1 million tons for the subsequent nine years.

The Iron Hill deposit lies east of the Transvaal border. This orebody also consists of hematite in banded ironstone. The probable reserves are 4.5 million tons of 54.8 per cent Fe and nine million of 45.4 per cent.

Three other iron formations are probably not of immediate interest to the iron and steel industry in spite of substantial reserves:

(1) The Gege deposit has a probable tonnage of 55 million plus a prospective 90 million of limonite which averages 40 per cent Fe, 6.5 per cent Mn and 20 per cent SiO_2.

(2) The Maloma orebody contains 30 million probable tons of magnetite of 30 per cent Fe and 42 per cent SiO_2, and an additional possible tonnage of 45 million.

(3) The siderite deposit of Forbes Reef has a total of 6 million tons of probable and prospective ore. A borehole sample gave the following analysis: 38 per cent Fe, 2.9 per cent SiO_2, 0.1 per cent TiO_2.

South Africa

The 1962 production was 4,331,336 metric tons averaging 60 per cent iron.

The bulk of the production came from the Thabazimbi deposit in the Transvaal which has proved and potential reserves of several hundred million tons of hematite ore with an iron content of 57-60 per cent and low in phosphorus and sulphur.

Another substantial deposit is located near Postmasburg in the Cape Province. The mineral is hematite and the proved tonnage is about 200 million averaging 61 per cent Fe, 3.5 per cent SiO_2 and 0.05 per cent P.

A sedimentary deposit of oolitic chamosite occurs near Pretoria. The siliceous ore has an iron content ranging from 40 to 50 per cent and contains 0.1-0.3 per cent of phosphorus. The indicated reserves are of the order of several thousand million tons.

The Minerals Bureau in Johannesburg has transmitted the following figures on the estimated iron ore reserves of the Republic of South Africa:

	Million metric tons
High grade (+55% Fe)	1,200
Low grade (40-55% Fe)	5,400
Titaniferous ore	2,000

South West Africa

There are relatively large iron ore deposits in South West Africa, but reserve tonnage figures are not yet available. The Windhoek deposit has been estimated to contain 300 million tons of potential ore with a high silica content. No production is reported since 1958 when some 8,000 tons of iron ore were extracted.

Angola

Practically no information on Angola's iron ore resources is available. The most important known deposit appears to be Cassinga in southern Angola which is scheduled to produce at an annual rate of 2.5 million tons. In central Angola the iron ore mines of Cuima are the main deposit from which it is hoped to extract 250,000 tons in 1963.

Summary of coal production and reserves in Africa
(Million tons)

	1962 production	Reserve tonnages (a)	(b)	(c)
North Africa				
Morocco	0.370	100	—	—
Algeria	0.053	60	—	—
Egypt	—	—	70	—
East Africa				
Ethiopia	—	—	—	10
Tanganyika	0.001	20	280	43
Northern Rhodesia	—	—	—	50
Southern Rhodesia	2.826	800	—	15
Central Africa				
Congo (Leopoldville)	0.076	120	—	—
West Africa				
Nigeria	0.634	40	190	72
Southern Africa				
Madagascar	—	—	60	—
Mozambique	0.297	4	—	5
Bechuanaland	—	—	—	500
Swaziland	—	250	—	—
South Africa	41.275	42,745	—	—
Total	45.532	44,139	600	695

Coal and lignite

North Africa

Morocco

The Jerada coalfield is at present the most important producer in North Africa. In 1962 370,000 tons of anthracite were extracted: the acual productive capacity is double this figure. The reserves are estimated at around 100 million tons.

Algeria

Considerable reserves are reported at Colomb Bechar, site of the Houillères du Sud-Oranais. The coal is of poor quality with an 18-25 per cent ash content. Narrow seams render the extraction uneconomic.

Tunisia

No coal deposits are known, but a lignite deposit on the Cap Bon peninsula has been prospected. The reserves are estimated at 20 million tons with a 45 per cent C content and 40 per cent volatile matter.

Egypt

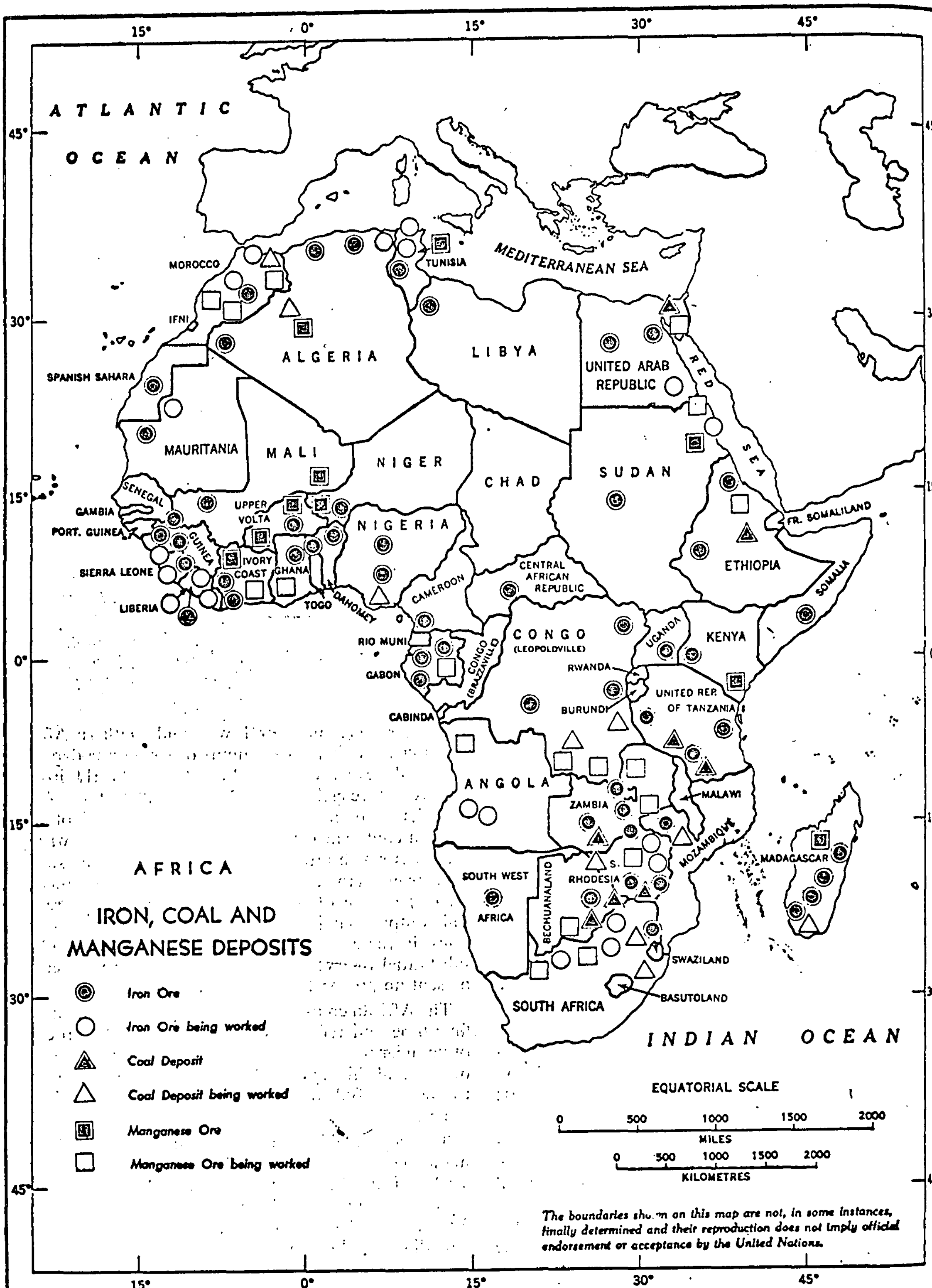
Two deposits are found on the Sinai Peninsula; coal seams outcrop at Maghara and are 500 m be[illegible] surface at Ayen Moussa. Exploration is taking plac[illegible] present and indicates a total tonnage of 40-100 mill[illegible] Although this coal is young, it has a low ash content [illegible] relatively high calorific value. Preliminary tests s[illegible] that it has coking qualities, attributed to the pres[illegible] of resin.

A substantial deposit of carbonaceous shale is [illegible] known on the Sinai peninsula. The indicated rese[illegible] are several hundred million tons of material avera[illegible] 30 per cent carbon, 30 per cent ash content and w[illegible] calorific value of 1,700-2,200 cals/kg.

East Africa

Ethiopia

The Nejo deposit in Wollega province is [illegible] prospected at present. The indicated reserves are 10 [illegible] lion tons of semi-coking coal.



MAP NO. 1563 UNITED NATIONS
NOVEMBER 1964

RAW MATERIALS FOR IRON AND STEEL MAKING IN THE ECAFE REGION

(DOCUMENT ECAFE.1) [1]

General

It is becoming clear to the countries of the ECAFE region that the development and the maximum utilization of their mineral resources are essential for their industrial growth. An assessment, however, at this stage of the availability of raw materials (particularly iron ore and coal) for the production of iron and steel in these countries should be considered incomplete. Many of the countries of the region, especially the less developed areas, have not been covered by detailed geological studies, mapping or exploration. This work is being vigorously continued in some of these countries, under contracts with independent foreign consulting firms and/or with the assistance of the agencies of the United Nations in collaboration with their respective Governments. The results of past explorations and the recent mineral surveys have generally indicated the existence of potential reserves of iron ore and coal deposits of varying characteristics and magnitude which could perhaps be used as raw materials for the production of iron and steel, with the use of either the conventional methods and/or by the latest techniques in iron and steel technology which are now being practised in some of the highly industrialized countries.

Countries of the region [2]

AFGHANISTAN [3]

Afghanistan is endowed with rich mineral resources, particularly iron ore and coal deposits. Absence of adequate capital, transport facilities and dearth of technical personnel have deterred exploitation of these resources in the past.

Iron ore. Substantial deposits of high grade (Fe 64 per cent) hematite and magnetite ores were recently located in the Khakrez Kandahar area and also in Jabelseraj, Herat and other parts of the country. Potential reserves are estimated at over 20 million tons.

Coal. Coal deposits, of coking quality, of approximately 60 million tons exist at the Karkar and Ishpushta mining areas and the Daraa-il Suf deposit. Coal production has reached about 50 thousand tons yearly with the improvement of facilities. The programme of mineral resources development under the second five-year plan (1962-1967) has two objectives: (*a*) establishment of raw material basis for the construction of the first iron and steel plant; (*b*) development of mineral resources for export to improve the foreign exchange position.

Power generation sources. The installed generating capacity aggregated 59 MV in 1961.

BURMA

Iron ore.[4] Exploratory work in northern part of Burma (Tavoy and Taunggyi areas) by German experts indicated deposits of hematite and limonite ores, estimated at 6.5 million tons with an average Fe content of 47 per cent, Mn 0.8 per cent, SiO_2 1.55-15 per cent, P 0.04 per cent and TiO_2 0.5 per cent. Magnetite ores were also found in the area with a Fe content of 60 per cent and low in P and S.

Coal. Coals of bituminous non-coking quality have been found in Kalewa. They has low ash and sulphur contents. The mines are not accessible by good roads. Transport by water is possible. Reserves were estimated at about 6 million tons.

Scrap. Present scrap resources are inadequate for the electric smelting furnace. Imports of billets or scrap will be necessary to maintain continuous operation.

Power generation sources. The installed generating capacity in Burma in 1961 aggregated 190.9 MW.

CAMBODIA

Iron ore. Exploration of iron ore and coal deposits has been given priority in the (1960-1964) development plan. The Phnom Deck region contains iron ore deposits. Limestone deposits in the Kampot province have also been explored.

Power generation sources. In 1961, the over-all installed generating capacity amounted to 26.7 MW.

CEYLON

Iron ore.[5] Recent explorations for iron ores in Ceylon have revealed good grade deposits of limonite of Fe 50 per cent in the south-west area of the country. The estimated quantity is about 5 to 6 million tons. In the Chilaw, Tambakanda area, magnetite ores have been located with an estimated quantity of not less than 3.5 million tons.Further geological surveys and explora-

[1] Prepared by the secretariat of the Economic Commission for Asia and the Far East. See page 121 for discussion.

[2] *Mineral Resources Development Series* — E/CN.11/565, United Nations-ECAFE publication.

[3] *Survey of Progress, 1960* — Ministry of Mines and Industry, Afghanistan.

[4] *Report No. 2, Geological Survey of Iron Ore Deposits*, vol. I, 1955 — Burma, Ehrenberg-Koch.

[5] *State Industrial Projects, Bulletin 1*, Development Division, Ministry of Industries, 1961.

tions of mineral resources are being undertaken in the country. Limestone deposits are also found in various places.

Coal. There is no coal in Ceylon. All coal used for industrial purposes is imported. There are, however, wooded areas in the country, from which charcoal could be produced for a small steel industry. Organized and systematic reforestation and planting of rubber-wood trees will have to be introduced in order to provide continuity of charcoal supply.

Power generation sources. The installed capacity in Ceylon was about 94.2 MW in 1961.

CHINA (TAIWAN) [6]

Iron ore. China (Taiwan) has no significant iron ore deposits. However, limited supply of magnetic beach placers occur on the shores, north of the Tatum Volcanic Group between Tanshui and Keelung, along the coast east of the Taitung coastal range. The northern iron sands contain an average of about 80 per cent magnetite and about 15 per cent of ilmenite. In the concentrated form, the Fe contents average about 55 per cent and Ti about 3.5 per cent. The beach sands in the Tanshui coast contain a high percentage of ilmenite, ranging from 50 to 70 per cent and magnetite from 4 to 20 per cent.

Manganese ore. Deposits of manganese ores are also limited in the country. Good grades of psilomelane manganese ores are found in the south-eastern part of the Simaoshan area. Characteristics of the deposit contain Mn 40 per cent, SiO_2 about 11 per cent, S about 0.03 per cent and P about 0.03 per cent. Production is limited and the total reserves are estimated at less than 500,000 tons.

Scrap. The scrap used in the electric arc furnaces is imported. In 1960, imported scrap amounted to about 144,558 metric tons and in 1961 import was 108,841 metric tons.

Coal. There are deposits of coal in the northern part of the country estimated at about 200 million tons of workable reserves. Existing reserves have been estimated at about 415 million tons. The coal areas are mostly located in the northern part of the country and are divided into four regions: Keelung, Taipeh, Hsinchu and Chunan. Coals found in these regions range from good coking quality to non-coking or weak coking. These coals have the following general characteristics: fixed carbon, 41 to 55%; ash, 6 to 10%; moisture, 3 to 7%; volatile matter, 36 to 40%; sulphur, 0.6 to 3 %; phosphorus, 0.02%; and B.T.U./lb, 13,000.

Production of coal reached 3.7 million tons in 1960. The target output for 1964 has been set at 4.9 million tons. Coke is produced by numerous small beehive ovens and by about 22 by-product coke ovens. A new modern by-product oven was installed about two years ago. In 1962, about 32,000 tons of good quality coal was exported to Japan.

Mineral oil and natural gas. Petroleum and natural gas have been produced in the past in the country. A new large source of natural gas was located recently in the Chinshui area.

Limestone. Limestone deposits of commercial importance have been found in the south-western and north-eastern part of the country.

Power generation sources. The aggregate installed generating capacity in the country was 923.4 MW in 1961.

INDIA

Iron ore.[7] India has large iron ore deposits. Deposits of high grade hematite ores are found in Bihar, Orissa, Madya Pradesh, Bombay, Madras, Andra and Mysore. Reserve potentials are estimated at about 21,000 million tons of high grade ores, 60-65 per cent Fe content. New ore deposits are being developed to meet additional future requirements of the steel industries in the country and also for export.

The consumption of iron ore in the iron and steel industry is about 7 to 8 million tons yearly. This consumption is expected to double in the third plan and export is also predicted to increase to 10 million tons for the same period. The Kiriburu iron deposits in Bihar-Orissa; Bailadila in Madya Pradesh and Radi in Marashtra are being intensively developed to meet these additional requirements. The production of iron ore rose from 2.97 million tons in 1950 to about 10.5 million tons in 1960. About 3.2 million tons of high grade ores ranging from 62 to 65 per cent Fe content were exported in 1961.

Manganese ore. Manganese ores exist in considerable quantities in the country to support the present and future domestic demands and for exports. About one million tons are exported annually. It is estimated that the present rate of consumption of manganese ores for all purposes amounts to 400,000 tons and it is expected to increase to one million tons in 1970.

Coal. The total workable coal reserves are estimated at about 50,000 million tons and about 2,000 million tons of lignite deposits. The coal deposits are located in Bihar and West Bengal with small outlying fields in Assam, Madya Pradesh, Maharashtra, Orissa and Andra Pradesh. Lignite deposits are found in parts of Madras, Rajasthan, Gujarat and Jamnu and Kashmir. The reserves of good quality coal for metallurgical purposes are limited. Coking coal reserves are mainly found in Jharia, Ranigary and Bokaro coal fields. The Indian coals are generally high in ash content and need beneficiation. Coal from some of the other coal fields in central India can be used, after washing and blending with Jharia coals, for the manufacture of metallurgical coke.

The production of coal in India was 38.2 million tons in 1955 and 54.62 million tons in 1961. The target for the third plan is 97 million tons.

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[6] *Mining Development in Asia and the Far East, 1960, Mineral Resources Development, Series No. 16* — E/CN.11/565. *The Industrial and Mining Programme under Taiwan's Third and Fourth-Year Plan*; Industry of Free China — vol. XIX, No. 3 — March 1963.

[7] *The Third Five-Year Plan,* Government of India Planning Commission. *Progress of Industrial Development of India, 1956-1961,* Government of India Planning Commission.

Mineral oil and natural gas. The oil and natural gas commission of the Indian Government undertook intensive geological and geophysical surveys in parts of Punjab, Ganga valley and other areas. Natural gas was also found in the country.

Power. The total installed capacity in the country amounted to 5,183.3 MW in 1961.

INDONESIA

Iron ore.[8] Large deposits of iron ores have been found in the Archipelago, but most of these are complex ores with nickel and chromium contents. These deposits located in central Celebes and Borneo are estimated to exceed 500 million tons. The deposits in central Java are about 35 million tons with a Fe content of 60 per cent but adulterated by a 10 per cent titanium content. The only workable ores are found in Lampong (Sumatra), about 2 million tons, and about 2 million tons in Pleihari (south-east Kalimantan).

Coal. Bituminous and sub-bituminous coals abound in several islands of the Archipelago, in south Sumatra, east Borneo and a few areas in Java. These are of the non-coking quality. It is estimated that the coal reserves amount to 500 million metric tons. Indonesia is also rich in lignite deposits. In the Bukit Azam area, the amount of lignite is estimated at 2,000 million tons.

Pre-war production of coal in the Ombilin (central Sumatra), Bukit Asam (south Sumatra), Paropattan (north-eastern Borneo), east Borneo and three other private mines reached about 2 million tons. Investigation of the coal resources and large-scale coking tests with samples from Ombilin and east Bukit Asam showed: (*a*) that the Ombilin coal is suitable for producing a metallurgical coke in the vertical oven; the tumbler strength of the coke produced makes it suitable for use in a blast furnace with an output of 150 tons of pig iron per day; (*b*) preliminary investigation of the Bukit Asam coal showed that the coal had no coking properties and the double coking process was tried for producing metallurgical coke from the coal. The results showed that double coke could be produced when high temperature coke was used as a primary product.

Charcoal and oil. Sufficient quantities of charcoal can be produced to maintain a charcoal blast furnace in east Sumatra. Oil is available in south-east Sumatra in considerable quantities.

Power. The total installed generating capacity was 310.8 MW in 1961.

IRAN[9]

Iron ore. Iran has substantial deposits of iron ores occurring principally in three regions: (*a*) the north-east near Simnan: magnetite ores with an average Fe content of 60 per cent and low in P and S; no estimate of reserves has been made; the deposits are close to the Trans-Iranian Railways; (*b*) Kerman Province in various places (Bafgh Narikaw and Zirkan): magnetite ores with an average Fe content of 55 per cent with slight impurities of phosphorus and titanium. This area is near the coal mines. Reserves are estimated at 30 million tons; (*c*) Shams Abad-Arak: limonite and hematite deposits with average Fe content of 47 per cent and Cu of 0.217; estimated reserves range from 30 million (possible) to 100 million tons (probable); the southern railway passes through this region. Other iron deposits are in Ghasr, Fironzeh, near Tehram and southern isles of the Persian Gulf (Foroor island and Amoy).

Coal. Coal deposits are found in:

(*a*) The Elburz area with a reserve of about 10 million (possible) to 40 million tons (probable). Many of the coals are of the coking quality. The "Zirab" coals (slightly inferior) when blended with the Eleca and Gelandrood high-grade coals produce a coke suitable for blast furnace operation.

(*b*) The Kerman area with a probable reserve of about 100 million tons. The most promising is at the Hodjedt mines, with large deposits of coking coals suitable for metallurgical purposes; proven reserves are estimated at 25 million tons and probable reserves at 48 million tons. In the Badamuyeh area, the coking quality coal reserve is estimated to be about 44 million tons. Coal production is about 200,000 tons per year.

Manganese ore and petroleum gas. Manganese deposits are found in two areas: Ardestan and the province of Tehran. The ores in Ardestan contain about 54 per cent manganese. In the Tehran region, the manganese contents average about 30 per cent and by concentration, the purity can be increased to about 44 per cent. Total reserve is estimated to be about 500,000 tons.

JAPAN

Iron ore.[10] Japan's iron and manganese ore resources are inadequate for its needs. The deposits consist mainly of magnetite, hematite, and limonite and iron sands. Most of the ores are found in the north-eastern part of Japan (Hokkaido) and northern Honshu. The Fe contents range from 28 to 53 per cent Fe. The average Fe content of ores, however, is 37 per cent. The iron sand deposits (placer) are distributed along the seashores and in the foothills of the coastal ranges located also in Hokkaido and in various areas in Honshu (Aomori, Chinba). The Fe content of these placer deposits generally runs from 12 to 30 per cent Fe, and in concentrate form the average Fe content is about 57 per cent.

In 1958, about 1 million tons of iron ore and about 1 million tons of iron sand concentrates were produced. Pyrite and phrrhotite cinders are rapidly being used in the iron and steel industry in the country. Production reached a total of approximately 4.67 million tons in 1962.

The estimates of iron ore reserves in Japan including areas with 25 per cent Fe content are about 37 million

[8] *Mining Development in Asia and the Far East, 1960, Mineral Resources Development Series No. 16.*

[9] *Mining Development in Asia and the Far East, 1959, Mineral Resources Development Series No. 15,* E/CN.11/565. Information on Iranian Mineral Resources, Dr. T. Ziai, 28 November 1959.

[10] *Geology and Mineral Resources of Japan,* Second Edition, 1960, by Geological Survey of Japan.

tons and about 160 million tons of iron sand with an average Fe content of 13.9 per cent. Because of the paucity of domestic ores, the Japanese iron and steel industry depends greatly on the importation of iron ore. The principal sources of iron ore imports in 1962 were from Malaya (29.2 per cent), India-Goa (21.3 per cent), Chile (13.6 per cent) and the balance from Canada (7.1 per cent), Philippines (6.7 per cent), United States (3.9 per cent), South Africa (2.7 per cent), Brazil, Korea and others (4.2 per cent). Recent figures indicate a total consumption of about 27 million tons of iron ore, 80 per cent of which were imported. The Japan Iron and Steel Federation estimates an importation of 45 million tons of iron in 1970 to meet the target output of crude steel of 48 million tons for that year.

Manganese ore and scrap. Estimates show a possible reserve of about 5.6 million tons of metallurgical manganese ore with an average 30 per cent Mn. Annual production in the country amounts to approximately 300,000 tons. Metallurgical manganese ores are imported from India, the Philippines and from western countries. Japan also imports scrap from various countries to supplement the great quantities of home scrap generated in the country. About 20 to 30 per cent of the total scrap consumption in 1962 (13.3 million tons) was imported from the United States (74.2 per cent), from the United Kingdom (7.1 per cent), and the balance from India, Canada, Australia and Hong Kong (18.7 per cent).

Coal. In Japan, there is almost no production of metallurgical coal except for a small quantity in northern Kyushu. All the metallurgical coals are imported from foreign countries. The coal types in the country percentage wise are mostly bituminous and sub-bituminous (94.5 per cent), anthracite (2.7 per cent) and low-rank lignite (2.8 per cent) located in Hokkaido and Kyushu. The total theoretical recoverable coal reserves (1958) [11] are estimated at 20.8 million tons. The bitunious (high-grade) coals are of coking quality, the anthracite and lignite types are non-coking. The low-grade sub-bituminous types however are either weak coking or non-coking. Local production in Japan, excepting lignite, amounted to 52.6 million tons in 1960 and 60 million tons in 1962. The scarcity of metallurgical coals in Japan makes it indispensable to import this raw material. In 1962, imports of high grades of coal amounted to approximately 9.64 million tons. The projected crude steel output of 38 million tons in 1965 and the target output of 48 million tons in 1970 will mean coal imports of 20 and 24.5 million tons respectively. Estimated total workable reserves are about 30,000 million tons.

Limestone. Limestone is available in abundance in Japan. About 400 mines are working at present. These mines are located in Saitama, Tokyo, Fukuoka, Oita, Yamaguchi, Shiga, Shizuoka, Niigata and Tochigara prefectures. The characteristics of the limestone deposits are generally as follows: CaO, 52 to 55%; MgO, 0.16 to 0.21%; SiO_2, 0.25 to 0.18%; and ignition loss, 42 to 44%.

Power generation sources. The total installed generating capacity in Japan was 22,755 MW in 1961.

[11] *Ibid.*

Republic of Korea [12]

Iron ore. The iron ore deposits in South Korea are relatively low grade in quality and with an average Fe content of 30 per cent. Production increased from 261,000 tons in 1958 to about 500,000 tons in 1961. Emphasis is being given to further exploration for the ores.

Coal. The great reserves of coals in South Korea are anthracites and recent estimates indicate a potential reserve of about one thousand million tons. Accelerated development of these coal deposits have been emphasized in the new programme of mineral development. Production of coal increased from 867,000 tons in 1953 to about 5,900,000 tons in 1961 and to about 6,886,000 tons in 1962.

Power generation sources. The total installed capacity is about 367.3 MW in 1961.

Federation of Malaya [13]

Iron ore. The Federation of Malaya has large high-grade iron ore deposits with an Fe content ranging from 50 to 60 per cent. The possible reserves of known areas are estimated at 50 million tons. No extensive geological surveys has been made particularly in the east Malaya jungles, which geologists believe have large and undisclosed deposits of ore. Most of the good grades of iron ore are exported to Japan and small quantities to Europe and China (Taiwan). Production in the mining areas has reached about 6 million tons yearly against about 3 million tons in 1957 and about 500,000 tons in 1950.

Coal. There is no coal production at present. Coals found in the various areas in the Federation are lignites and low-grade sub-bituminous types. The good quality coal field area is located at the Batu-Arang field. Other coal areas of lower grades are known in Selangor near Engger, Perak on the border of Porlis and lower Thailand and Johore. These coals are non-coking and not suitable for metallurgical purposes, particularly in blast furnace operation.

Power generation sources. The installed capacity in 1961 was 315.2 MW.

Pakistan [14]

Iron ore. Iron ore deposits in quantities are known near Chagai in north-west Baluchistan, at Damnar Nissar in Chitral, and at Kalabagh and Chichali in north-west Punjab. The deposits in Chagai and Damnar Nissar are of relatively high-grade quality with an Fe content of 60 per cent. These areas are isolated and difficult of access. The ores at Kalabagh and Chichali are of inferior grade with an Fe content of 30-35 per cent. These deposits are fairly accessible. The deposits are extensive in both

[12] *The Status of Progress of Industrialization in Korea, 1963,* Ministry of Commerce and Industry, Republic of Korea.

[13] *Mining Development in Asia and the Far East, 1959, Mineral Resources Development Series No. 15,* C/EN.11/565 — E/CN.11/I & NR/44.

[14] *The Second Five-Year Plan, Pakistan, 1960-1965,* Government Planning Commission.

these areas and the potential reserves are believed to be over 100 million tons. Emphasis has been placed in the second five-year plan for iron ore development for possible use in the proposed integrated steel mill in the country.

Coal. Large coal reserves are found in several areas in Pakistan, but no accurate estimate can be made, owing to the lack of detailed mapping and prospecting. Sizable deposits exist at Makerwal and in the western Salt Range; at Sharing Deghari and in the Sor Ranges, south and east of Quetta; and in the vicinity of Jhimpir in the Hyderbal Division. Local mines at present in the Makerwal and Quetta areas are predominantly narrow seams and mechanization of the operation presents a problem. The coal is friable and high in sulphur and ash content and thus unsuitable as metallurgical coke for blast furnace operation. By subjecting this coal to low carbonization, a coke briquette can be produced for use in foundries, lime kilns, brick kilns and as boiler fuel. In east Pakistan, a deposit of coal has been reported from Bogra and Rajshabi.

Local production in 1959 reached a total of 723,000 tons and the second plan proposed to increase this to 1,500,000 tons annually to reduce substantially imports of coal which amounted to 1.34 million tons in 1958. There is a plan also to consolidate small mining units to achieve more efficient operation. Government assistance will be extended to this small group in the form of financing new equipment purchases through the Pakistan Industrial Investment Credit Corporation and the Bureau of Mineral Resources for securing the foreign exchange requirements.

Crude oil and natural gas. Crude oil is produced in small scale in the area near the Potwar Basin. Oil was struck in 1959 near Balkasar, south-west of Rawalpindi, but reserves are small. The search for oil uncovered valuable fields of natural gas. The most important fields were discovered at Sui, where reserves of high quality gas with calorific value of 930 B.T.U./cu.ft. and estimated at 6,000,000 million cubic feet. The recently discovered field at Mari is estimated at 3,500,000 million cubic feet. Both of these fields will supply West Pakistan with gaseous fuel (and petrochemical materials) for many decades. In east Pakistan, the most important fields of natural gas were found near Chattak of about 20,000 million cubic feet. Projected combined output of these two fields will reach 7,500 million cubic feet in 1965. There are prospects for the discovery of new fields in east Pakistan.

Scrap. There is no significant scrap generation in Pakistan to maintain a stable operation of the electric furnaces and scrap is imported.

Power generation. The installed capacity was 687.7 MW in 1961.

PHILIPPINES

Iron ore.[15] The Philippines has substantial deposits of iron ore, which is being exported to Japan in large quantities. The mines are located in these areas: Luzon (northern Philippines); Samar and Marinduque islands (central Philippines); and Mindanao (southern Philippines). The largest and best developed mine in the Luzon area is located at the south-east portion of the island at Larap, province of Camarine Norte. It has an estimated ore reserve of about 20 million tons and is operated by the Philippine Iron Mines, the largest producer in the country. Present production for export is about one million tons of magnetite ores with an Fe content of 42 per cent, sulphur content from 0.6 to 2 per cent and low in phosphorus. A beneficiation plant has been installed and presently a concentration plant (magnetic separation) is under construction. A new source of iron ore of high Fe content (57-62 per cent) has been explored and is being developed in central Luzon in the Sta. Inez area (Bulacan). Estimated workable reserves in this area are about 20 million tons. Ore content is about 1 to 4.6 per cent in sulphur and low in phosphorus. In the northern tip of this island (Luzon), recent explorations show a good grade of magnetite-hematite ore with Fe content of 50 to 70 per cent. The iron ore deposits in Mindanao are estimated at 20 million tons of good grade ores with an Fe content of 50 to 55 per cent, low in sulphur (less than a per cent) and traces of P. Most of the ores are located at the Sibuguey range. In the north-eastern tip (Surigao province) if this island are extensive deposits of lateritic ores with an average Fe content of 45 per cent and estimated at about 232 million tons. The ore, however, is of the complex type with nickel content of about 0.8 to 1.70 per cent and chrome content of about 1 to 3 per cent.

Manganese ore. Manganese abounds in various parts of the country with manganese contents from 37 to 48 per cent. The most prominent areas are located in the northern tip of Luzon (Ilocos provinces), Siquijor island (central Visayas) and in Busuanga island (Palawan group). Present production is about 15,000 to 19,000 tons yearly for export to Japan.

Coal. Coals are found in some parts of the Philippines in Luzon, Mindanao and in the central Visayas. The coal in the Malangas area (Mindanao) has been found to be of coking quality when blended. A small beehive oven of small tonnage has been in operation since 1960 and is being used by some electric furnace operators. Production of coal in Cebu and in Malangas is about 200,000 tons yearly. Extensive exploration is now being made to determine the potential and workable reserves in the Malangas area, for possible utilization by the proposed integrated steel plant. Malangas coal has the following analysis: fixed carbon, 50%; volatile matter, 30-35%; ash, 9% (max.); moisture, 4%; sulphur, 0.6%; and heating value, 10,000-12,000 B.T.U./lb.

The present estimate of reserves is about 10 million tons. All the coals found in the Philippines excluding Malangas are of non-coking quality. The biggest lignite deposit is located at Batan island in the southern tip of Luzon island. Sulphur content ranges from 0.8 to 2 per cent.

Limestone. Limestone is abundant in the Philippines.

Charcoal.[16] The destructive distillation of *ipil ipil, bakawan* woods and coconut shell which abound in the

[15] *Annual Report*, Bureau of Mines 1962 — E/CN.11/I&NR/44.

[16] *Annual Report*, Bureau of Mines, 1962.

country for possible metallurgical purposes have shown the following results:

	Bakawan	Ipip ipil	Coconut shell
Product yield (%) dry basis			
Charcoal	33.5	27.9	30.1
Liquor	31.8	30.2	37.5
Tar	10.8	10.2	9.6
Proximate analysis of charcoal (%)			
Moisture	2.90	7.16	4.76
Ash	7.33	6.03	2.50
Volatile matter	24.02	9.38	19.10
Fixed carbon	65.75	77.43	73.64
Heating value B.T.U./lb.	12,474	12,515	12,164

Scrap. The generation of scrap is very inadequate and the scrap shortage has reached serious proportions. It might be necessary to import scrap or billets from foreign sources during the next few years until the integrated steel project is completed.

Mineral oil and natural gas. Extensive explorations for oil in some areas have been in progress for the past few years. Indications of natural gas sources have been associated with these explorations.

Power generation sources. The installed plant capacity in the Philippines was 652.6 MW in 1961.

THAILAND

Iron ore. Thailand has deposits of iron ore in various areas. The largest deposit was discovered in Changwat Lopburi. The primary ore is hematite with an Fe content of 66.4 per cent, S of 0.08 per cent and Mn of 3.6 per cent. Other promising areas of ores are located in Kanchanaburi and Kanburi. Estimated reserves are 6 million tons. Lateritic ores are widely distributed in the country in small quantities. Magnetite pyrites exist in a few areas. Recent explorations show indications of considerable ore deposits in north-eastern parts of the country.

Coal. Coal occurs in widely scattered areas in the country. The deposits in northern Thailand are lignites with low calorific value. The coals in southern Thailand are rather dense and black with an HV of 8,000 to 10,000 B.T.U./lb. This could be considered as sub-bituminous in rank. The fixed carbon content on the average is between 40 and 49 per cent; volatile matter from 30 to 50 per cent; ash from 8 to 30 per cent; sulphur from 3 to 6 per cent and moisture content 8 to 30 per cent. Production is low and whatever is available is used by the thermal stations.

Power. The installed capacity was 264.5 MW in 1961.

VIET-NAM, REPUBLIC OF [17]

Mining activity during the last few years was concentrated on the improvement of the existing coal mines and on the investigation and assessment of other mineral resources.

Coal. Coal reserves in the Nong Son coal mine was estimated at 10 million tons. Other coal outcrops were discovered in this general area. Coal production in 1960 was about 27,300 tons.

Power. The installed generating capacity was 102.1 MW in 1961.

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[17] *Mining Development in Asia and the Far East, 1960, Mineral Resources Development Series No. 16* — E/CN.11/596.

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Table 1. Latin America: Steel production [a], imports and apparent consumption in 1962

(Thousands of metric tons of ingot steel)

Country	Steel production (ingot)	Steel imports (finished and semifinished steel)	Apparent consumption	
			Total	Per capita
Argentina	644	1,398	2,500	76
Brazil	2,587	370	2,957	39
Chile [b]	528	89	580	70
Colombia	156	300	400	27
Mexico [c]	1,712	207	1,890	53
Peru	71	120	190	16
Uruguay	8 [d]	110	120	44
Venezuela	142	650	850	76
Others	3	400	500	—
TOTAL	5,851	3,644	9,987	—

SOURCE: Several numbers of *Revista Latinoamericana de Siderurgia*, published by the Latin American Iron and Steel Institute and statistical yearbooks of foreign trade of some of the countries.

[a] Both from integrated and non integrated plants.

[b] Chile exports 63 thousand tons of steel.

[c] Mexico exports 40 thousand tons of pig iron.

[d] From imported billets.

of ten years ago, which may still be economic; (*c*) if, instead of considering steel production and demand as a definite product-mix, the many types of finished steel products are taken individually, one finds that the influence of economies of scale for individual products is so large that there is room for specialisation within Latin America in spite of high transport costs, and especially if trade within the Region is based on barter exchange of one type of steel product for others rather than foreign hard currency settlement; (*d*) it might well be that as soon as the above is appreciated by Latin American Governments and the steel industry itself, negotiations to facilitate such specialization may receive a strong impetus.

Latin American resources of iron ore

As a whole, Latin America is richly endowed with iron ore resources. The latest information available shows reserves of 20,529 million metric tons of ore. Of these a

Table 2. Latin America: Iron ore reserves and potential resources

(Millions of metric tons)

Country	Ore reserves	Yield iron (per cent)	Potential resources	Yield iron (per cent)	Total
Argentina	251 [a]	48	500	4 [b]	751
Bolivia	—	—	540	60	540
Brazil	15,421	58	28,059	35	43,480
Central America	20	60	—	—	20
Chile	337	62	1,250	51	1,587
Colombia	172 [a]	48	380	325	552
Cuba	—	—	2,500 [c]	45	2,500
Dominican Republic	50	67	—	—	50
Ecuador	1	66	—	—	1
Mexico	574	62	—	—	574
Peru	767	60	—	—	767
Uruguay	28	40	72	48	100
Venezuela	2,908	62	1,225	45	4,133
TOTALS	20,529	60	34,526	40	55,055

SOURCE: United Nations *Study of the Iron Ore Resources of the World*, 1954 (ST/ECA/27), data submitted by the geological bureaus of various of the countries and several numbers of *Revista Latinoamericano de Siderurgia*, published by the Latin American Iron and Steel Institute.

[a] Phosphoric ores with 0.8 to 1.0 per cent phosphorous.

[b] Ferriferous sands.

[c] Although there is plenty of high grade ore in well known deposits, these resources are considered to be only potential on account of varying contents of other ferrous metals, like chromium and nickel which complicate the production of iron and steel.

small fraction — some 420 million tons — consists of 48 to 50 per cent iron with a high phosphorous content of between 0.8 and 1 per cent. The rest is, in general, very rich ore, ranging from 58 to 68 per cent iron content and with low percentages of phosphorous and sulphur. These ores are generally of hematites at the surface, blended with magnetite, the Fe content of which usually increases with the depth at which the sample is taken. Other ferrous minerals, like limonite and others, are also frequently present, but in smaller proportions.

Table 3. Latin America: Geological information and analyses of iron ore reserves [a]

Country and deposit	*Type of formation*	*Type of mineral*	*Reserves (millions of tons)*	*Analysis, percentages*			
				Fe	*SiO_2*	*P*	*S*
Argentina							
Sierra Grande	Minette	Magnetite [b]	145	56	6	1.5	0.5
Zapla	Lake Superior	Hem. & Lim.	106	40	35	0.3	0.1
Brazil							
Minas Gerais	Lake Superior	Hematite	2,096	66	0.5	0.03	0.01
Minas Gerais	Lake Superior	Hematite	3,000	50	6.0	0.14	0.01
Minas Gerais	Lake Superior	Itabirite	10,000	35	20.0	0.12	0.01
Urucum	Lake Superior	Itabirite	300 [c]	62	4.5	0.16	0.04
Parana	Massive	Magnetite	21.6	60	0.2	0.02	0.01
Chile							
Carmen	Kiruna	Magnetite	10	63	3.5	0.30	0.10
Las Adrianitos	Magnitnaya	Mag. & Hem.	10	64	4.0	0.01	0.04
El Algarrobo	Kiruna	Mag. & Hem.	120	64	5.5	0.15	0.05
Cristales	Kiruna	Mag. & Hem.	15	64	4.0	0.02	0.40
Banduna	Kiruna	Hematite	50	60	6.0	0.02	0.01
El Plaito	Kiruna	Hem. & Mag.	10	60	3.5	0.17	0.02
El Romeral	Kiruna	Hem. & Mag.	80	63	7.0	0.25	0.12
Colombia							
Pas del Rio	Minette	Hematite [b]	130	48	10.0	1.00	0.07
Cerro Matoso	Laterite	Hem. & Mag.	40	50	6.0	0.10	0.20
Dominican Republic							
Hatillo	Bilbao	Magnetite	50	67	1.5	0.03	0.09
Mexico							
Cerro El Marcado	Kiruna	Hem. & Lim.	70	62	3.9	0.70	0.25
La Perla	Magnitnaya	Hematite	50	60	7.0	0.11	0.30
Santa Urzula	Magnitnaya	Hematite	30	62	3.7	0.10	0.20
El Mamey	Magnitnaya	Hematite	131	65	12.6	0.10	0.20
El Encino	Magnitnaya	Hematite	16.5	60	4.5	0.32	0.13
Las Truchas	Magnitnaya	Hematite	73	59	7.5	0.04	1.14
Zaritza	Magnitnaya	Hematite	30	65	1.7	0.03	0.37
Peru							
Marcona	Magnitnaya	Hem. & Lim.	670	60	4.0	0.18	0.40 [d]
Huacraviloa	Bilbao	Hematite	64	60	4.0	0.10	0.60
Tambo Grande	Bilbao	Hematite	32	46	8.0	0.20	0.40
Venezuela							
Cerro Bolivar	Lake Superior	Hematite	1,686	62	0.7	0.15	0.01
El Pao	Lake Superior	Hematite	242	64	0.3	0.03	0.03
San Isidro	Lake Superior	Hematite	830	60	3.0	0.15	0.01
Maria Luisa	Lake Superior	Hematite	150	64	0.9	0.15	0.01

SOURCE: United Nations *Study of the Iron Ore Resources of the World*, 1954 (ST/ECA/27); information received from the geological bureaus of some countries of Latin America and data obtained from several numbers of the *Revista Latinoamericana de Siderurgia* of ILAFA, the Latin American Institute for Iron and Steel.

a In the table only the countries with known "reserves" are mentioned and only deposits with 10 million tons or more.

b Magnetite and colythic hematite.

c Urucum has, in addition, 10,000 tons of ore with 50 per cent grade which are considered as potential resources due to the unfavourable location.

d Marcona has also 1.5 per cent copper or additional impurity.

In addition to these reserves, potential resources of about 34,526 million tons have been located.[2] The average yield in iron ore of these potential resources is relatively low, about 40 per cent. Some high grade ore deposits have been tabulated as potential resources, like the Mutun formation in Bolivia and the Laco deposit in Chile, because transport costs to consuming centres or to tide water for export, would be too high at present. Similarly, some high grade ores which contain chromium or nickel have been included as potential resources, due to the metallurgical difficulties in smelting such ores.

Table 2 shows the currently known reserves and potential resources of iron ore in Latin America, by countries, as well as their average iron content. In addition to the deposits tabulated in table 2, there are many countries and sites with outcrops and indications of possible existence of iron ores, that would justify exploration work. Unless such work and studies have been carried out, the possible formations have not been considered here at all.

Comparing the 55,083 million tons of total reserves, actual and potential, shown in table 2 with the corresponding figure for the whole of the Latin American Region published in the 1954 *Study of the Iron Ore Resources of the World*, one finds that the latter was only 49,775 million tons. The increase of some 5,000 million tons is the consequence of considerable study and exploration work carried out in several Latin American countries, especially Venezuela, Chile and Mexico, in that order. While making this comparison it must be regretted that the limitation of time available for the preparation of this study did not make it possible to investigate in more detail the latest developments in Cuba and Peru, countries regarding which no new information was received.

Table 3 gives an indication of the geological data and the analysis of the impurities contained in the main formations comprising the deposits included as reserves. More detailed information for each one of the deposits is given in the annexes in which the data have been compiled country by country.

Of the thirteen Latin American countries shown in table 1, in which iron ore deposits have been identified, those resources are being exploited in only seven of them. Table 4 shows the iron ore production and its destination in 1962. The figures of table 4 show that less than 20 per cent of the iron ore mined in Latin America is used within the region for steel production. The destination of the exports in 1962 is shown in table 5.

[2] After this paper was written, United Nations experts arrived at the conclusion that the deposit at Mutun, Bolivia, to a depth of 200 metres, is a potential resource containing 45,000 million tons of ore of 54 per cent iron, 20 per cent silica, 0.13 per cent phosphorous and 0.15 per cent sulphur. The older data, which gave Mutun a potential of 540 million tons, have been used in this paper.

Table 4. Latin America: Exploitation of iron ore resources and use of the ore in 1962

(Millions of metric tons)

Country	Production	Consumption	Exports abroad or within the Region
Argentina	0.13	0.65	−0.51
Brazil	10.50	3.00	+7.50
Chile	8.09	0.60	+7.50
Colombia	0.42	0.42	—
Mexico	1.30	1.30	+0.15
Peru	5.23	0.18	+5.00
Venezuela	13.20	0.80	+14.00
TOTAL, Latin America	38.77	6.95	+33.64

SOURCE: Statistical yearbooks of foreign trade of some countries and several numbers of the *Revista Latinoamericana de Siderurgia*, published by the Latin American Iron and Steel Institute.

Table 5. Latin America: Destination of iron ore exports in 1962

(Millions of tons)

Country of destination	Country of origin: Brazil	Chile	Peru	Venezuela	Total
North America					
Canada	0.33	0.07	—	—	0.40
United States	4.40	3.40	0.70	10.00	18.50
Europe					
Italy	0.35	0.30	0.30	0.80	1.75
United Kingdom	0.27	—	0.30	1.70	2.27
Federal Republic of Germany	1.10	0.58	0.30	1.50	3.48
Czechoslovakia	0.25	—	0.35	—	0.60
Poland	0.30	—	—	—	0.30
Asia					
Japan	0.50	2.95	2.75	—	6.20
Latin America					
Argentina	—	0.20	0.30	—	0.50
TOTAL	7.50	7.50	5.00	14.00	34.00

SOURCE: Some handbooks of foreign trade statistics from the countries and several numbers of *Revista Latinoamericana de Siderurgia*, published by the Latin American Iron and Steel Institute.

As a matter of fact, exploitation of some of the very rich iron deposits of Latin America was started at the turn of the century by a few captive mines belonging to some of the large American steel companies: Cuba and Mexico were the first countries in which this type of mining began, to be followed later by Chile and now more particularly by Venezuela. From the outset, the mining companies undertook to sell at cost to local companies in the country concerned the amounts of iron ore which they might need for internal steel production. The organization of iron mining companies in Latin America exporting ore in the free market is a more recent development and was probably started in Brazil by the Companhia do Vale do Rio Doce, the biggest free exporter at present in the Region. Table 6 shows, as far as is known, the iron ore exports by free and by captive mines in Latin America in 1962.

Table 6. Latin America: Iron ore exported in 1962 by captive and by free mines

(Millions of metric tons of iron ore)

Country	Captive mines	Free mines	Total
Brazil	—	7.50 [a]	7.50 [a]
Chile	2.20	5.30 [a]	7.50 [a]
Mexico	—	0.15	0.15
Peru	—	5.00 [a]	5.00 [a]
Venezuela	14.00	—	14.00
TOTAL	16.20	17.95 [a]	34.15 [a]

SOURCE: Estimates by the ECLA secretariat.

[a] Contains 0.51 million tons exported to Argentina jointly by Brazil, Chile and Peru.

Although steel production in Latin America began in Monterrey, Mexico, in the first years of this century, the real landmark of the growth of the industry is the beginning of operations at Volta Redonda, Brazil, in 1946. This, in spite of the fact that there had been earlier some developments at Monlevada in Brazil, Corral in Chile and Monclova in Mexico. Since 1946 the growth of the Latin American steel industry has been both sustained and impressive, with new plants starting production almost every year. Even so, the region is still a net importer of finished steel and will probably remain so for many years to come.

Concerning exports of ore, the organization of new mining ventures and the growth of the existing ones has been the result of the expansion of steel production in the industrialized countries, as a consequence of which ore prices have stayed relatively high and stable for the last five years. Only in 1962 was there a general drop in export prices of some 0.50 dollars per ton. Originally, these exports were due to the high iron content of the corresponding Latin American iron ores and their very low content of impurities, such as sulphur and phosphorus, which made lumps of Latin American ore an ideal material for addition to the open hearth furnaces for cooling of the bath, assisting in the refining process through the liberation of oxygen to oxydize some of the impurities contained in the molten bath. Technological developments of the latest years, particularly the use of oxygen in the open-hearth furnaces, are changing these conditions to the disadvantage of Latin American exporters. Progress in the knowledge of the blast furnace operations are now causing a change in emphasis, from lump ore used in the open-hearth charge to well sized and washed or otherwise beneficiated ore for the blast furnace.

As a result of the tendency to use high grade ores for blast furnace charge, thus permitting a considerable increase in the output of the blast furnace with the corresponding saving in the coke rate, the industry in the industrialized countries is using more and more beneficiated material in the charge; be it sinter, washed and concentrated ore or pellets. This, together with the reduction of available high grade iron ore reserves in some of those countries, has motivated considerable research in relation to the beneficiation and concentration of iron ore deposits of lower grades.

In the blast furnace, at present, there is a tendency to use the natural high grade ore sized from 3/8" to 2 inches for hematites and 3/8" to 1 inch for magnetites. Preference is given to hematite on account of its greater reductibility but, in most of the Latin American mines, there is a tendency for the ore to get richer in magnetite as the depth increases. With the development of the technique called pelletization (grinding, magnetic concentration and semi-fusion through calcination in rotary kilns to form pellets) and of sintering, a charge of some 68 per cent of iron can be obtained even from rather low grade ores (30 to 40 per cent). These events are responsible for the fact that several of the Latin American iron ore exporters are either producing pellets, or are planning to do so, or wash the ore to eliminate most of the clay contained as impurity or, at least, to classify their product carefully. It is noteworthy that Japan is still importing lump ore which is crushed and beneficiated in Japan to obtain very high grade ore.

Leading in this tendency to improve the type and classification of their ore have been Marcona Mining Co. of Peru and Vale do Rio Doce in Brazil, followed later by Algarrobo in Chile. In spite of the fact that the above trends have been noticeable in recent years, Latin American iron ore production has grown steadily, as can be seen from the figures shown in table 7. It is expected that exports will continue to rise and may reach some 45 million tons in a few years time.

Manganese ore resources of Latin America

In addition to the high grade manganese ores, that are known in some of the countries, low grade formations are abundant in Latin America but as concentration to raise the area from 42 per cent manganese content to the 48 per cent required for export presents serious technological problems on the one hand, and with instability of world manganese prices on the other, the studies and exploration of manganese deposits are very far from being exhausted. Table 8 presents the latest known figures about manganese reserves in Latin America and the average annual production of the last few years:

Table 7. Latin America: iron ore production from 1950 to 1962

(Millions of metric tons)

Year	*Million tons*
1950	5.6
1951	7.2
1952	8.0
1953	10.2
1954	13.1
1955	16.6
1956	21.0
1957	27.4
1958	27.8
1959	30.5
1960	33.4
1961	36.8
1962	38.9

SOURCE: *Revista Latinoamericana de Siderurgia*, published by the Latin American Iron and Steel Institute.

Table 8. Latin America: manganese ore reserves and production

(Tons of manganese content in 45 per cent ore)

Country	*Reserves*	*Production*
Argentina	900,000	7,000
Bolivia	a	—
Brazil	30,000,000	440,000
Chile	420,000	14,500
Cuba	720,000	9,000
Mexico	4,500,000	35,000
Peru	b	1,000
TOTALS	36,540,000	506,500

SOURCES: *Minerals Yearbook*, US Bureau of Mines, information received from several Latin American Geological Institutes and Foreign Trade Yearbooks of the Governments.

a It is known that manganese ore exists, probably in considerable quantities, at the Mutun iron ore deposit, but the resource has not been sufficiently studied.

b In Southern Peru there are several manganese ore formations but little is known about their size and they are not being regularly exploited.

With the iron and steel-making processes currently employed there is a consumption of from 6 to 7 kg of metallurgical grade of manganese ore per ton of steel. Of the steel producing countries: Brazil, Chile and Mexico meet their own requirements and have a surplus for export; Argentina covers its internal demand while Colombia, Peru and Venezuela import their manganese ore of the corresponding ferro-alloy.

Fluxes for the Latin American steel industry

As almost everywhere in the world, lime deposits are abundant in Latin America and may be found in close vicinity to almost any plant location. For this reason when speaking of resources for producing iron and steel in the region, one may omit the problem of the provision of lime aside. Or course, when coming to the actual planning of a steel plant, this may not always be the case. It happens that the Chilean steel plant at Huachipate brings its limestone from an island in the far south of the country with an ocean haulage of some 1,500 kilometres. The deposits closer to the plant are of unsatisfactory grade. In the same way, in relation to the possibility of erecting a steel plant at Mutun, in Bolivia, one finds that the limestone deposits in the vicinity are only about 50 per cent grade. Whether better limestone can be brought from other more distant places in the country, or from large deposits of very high grade limestone in the South of Paraguay on river barges, or if it has to be obtained through flotation of the limestone close by, is a problem which has to be solved in due time but its importance is very great during the preliminary studies.

Concerning dolomite, there are large deposits of high quality in Brazil, Guatemala, Mexico and Uruguay. In most of the Latin American steel producing countries — Argentina, Chile, Colombia, Peru and Venezuela — there are usually some known deposits but the quality is not satisfactory for the steel industry and, therefore, the needs of the countries are supplied by imports.

Availability of scrap in Latin America

As no thorough survey has been made on the availability and production of scrap in Latin America, little is known about the possibilities and prospects of this important raw material for the steel industry. At least two factors would tend to restrict the present availability of scrap: on the one hand, steel consumption was rather small in most of the Latin American countries twenty or thirty years ago, so that the investments then made might now be ready for discard. The only exception to this general rule is Chile, where a considerable number of nitrate plants installed between the end of the last century and the great Depression, are being scrapped either because, a tightening market has made them uneconomical or because their nitrate ore reserves have been exhausted. On the other hand, capital being scarce in Latin America, there is a tendency to continue operations in existing installations long after they would have been discarded in more industrialized countries.

Nevertheless, the impression exists that it would be possible to collect much greater amounts of scrap than is being done at present, provided that the proper organizations were created, and fair prices paid for such material. In general, scrap prices range at present between 18 and 28 dollars per metric ton, depending on the country, the location and the quality of the material. In spite of this low scrap price, most of the integrated Latin American steel plants use a considerably higher proportion of hot metal and much less scrap in their open hearth furnaces than is customary in more advanced countries although the cost of hot pig iron ranges between 45 and 60 dollars per metric ton.

Another factor which makes it difficult for the large integrated steel plants to increase their supply of scrap is the fact that they are usually located at a considerable distance from the centres in which the metal working industries are located, which makes necessary long haulages to the plants. An exception here is Argentina, where the Somisa plant at San Nicolas has been located at a very short distance from Buenos Aires and Rosario,

ANNEX I

Argentina: iron ore resources and reserves

(In metric tons)

Ore bodies	Location	Type	Mineral	Percentages				Production 1962	Reserves				Potential reserves
				Fe	SiO_2	P	S		Proven	Indicated	Calculated	Total	
Sierra Grande . . .	30 km from the coast	Minette	Magnetite (oolythe)	56	6	1.5	0.5	—	20,000,000	60,000,000	65,000,000	145,000,000	
Zapla	Near Injuy	Lake Superior	Hematite and Limonite	40	35	0.3	0.1	134,000	6,000,000	50,000,000	50,000,000	106,000,000	
Ferriferous sands .	Coast		Magnetite and Limonite	4		0.5 de TiO_2			—	—	—	—	500,000,000
		Total estimated ore in 1961 [a]						134,000	26,000,000	110,000,000	115,000,000	251,000,000	500,000,000
		Imports of ore in 1962						515,000					

[a] Several other ore bodies are known, but with reserves of less than 1 million tons which would add up to about 4 million.

ANNEX II

Iron ore resources and reserves

(In metric tons)

Ore bodies	Location	Type	Mineral	Percentages: Fe	SiO_2	P	S	Production 1962	Reserves: Proven	Indicated	Calculated	Total	Potential resources
Uruguay													
Valentines	260 km N. of Montevideo	Lake Superior	Itabirite	40	20.00	0.01	0.03	—	28,000,000	—	72,000,000	100,000,000	—
Ecuador													
Pascuales	25 km N.E. of Guayaquil	Stratified	Magnetite	66	10.00	0.01	0.08	—	200,000	300,000	500,000	1,000,000	—
Bolivia													
Mutum	E. frontier	Stratified	Hematite	60	17.00	0.01	0.01	—	—	—	—	—	500,000,000
Veneros	E. frontier												
Mutum		Lode bed	Hematite	62	15.00	0.01	0.01	—	—	—	—	—	40,000,000
													540,000,000
Central America													
Guatemala													
Various deposits .	Ghiquimula	Magnitnaya	Hematite	60				—	500,000	—	3,000,000	3,500,000	—
Honduras													
Agalteca	35 km N. of Tegucigalpa	Magnitnaya	Hematite	53	10.00	0.04	0.02	—	—	3,000,000	5,000,000	8,000,000	—
Nicaragua													
Monte Carmelo .	35 km N.E. Managua	Magnitnaya	Hematite	60	7.00	0.02	0.02	—	—	—	8,500,000	8,500,000	
												20,000,000	
West Indies													
Cuba													
Mayari	20 km south	Latherite	Limonite [a]	45	4.00	0.02	0.03	—	—	—	530,000,000	530,000,000	
Moa	N.E. region	Latherite	Limonite [a]	45	4.00	0.02	0.06	—	—	—	1,570,000,000	1,570,000,000	
Camagüey	Caribbean	Latherite	Limonite [a]	46	5.5	0.03	0.06	—	—	—	400,000,000,	400,000,000	
												2,500,000,000	
Dominican Rep.													
Duarte Hatillo . .		Bilbao	Magnetite	67	1.5	0.03	0.06	—	—	8,500,000	41,500,000	50,000,000	

[a] Contains 1.7 per cent Cr and 2.0 per cent Ni.

ANNEX III

Chile: Iron ore resources and reserves

(In metric tons)

Ore bodies	Location	Type	Mineral	Percentages Fe	SiO₂	P	S	Production 1962	Reserves Proven	Indicated	Calculated	Total	Potential resources
El Laco Cia. Minera Santa Fe	300 km E. of Antofagusta	Kiruna	Magnetite and Hematite	63	1.50	0.35	0.10	—	—	—	—	—	250,000,000
Cerro Inán Soc. Minera Cerro Inán	79 km E. of Caldera	Kiruna	Hematite and Magnetite	62	3.50	0.01	0.01	740,000	630,000	2,500,000	2,500,000	5,630,000	—
Carmen Cia. Minera Santa Fe	50 km E. of Chañaral	Kiruna	Magnetite	63	3.50	0.30	0.10	1,000,000	3,000,000	2,000,000	5,000,000	10,000,000	—
Las Adriantas Cia. Minera de Atacama	50 km E. of Caldera	Magnitnaya	Magnetite and Hematite	64	4.00	0.01	0.04	300,000	2,000,000	5,000,000	3,000,000	10,000,000	—
Los Colorados — etc. Cia. de Pierre de Atacama	52 km E. of Carrinal	Kiruna	Hematite	62	9.00	0.06	0.05	180,000	1,000,000	2,500,000	3,500,000	7,000,000	—
Huantané Cia. Minera Santa Bárbara	48 km E. of Huasco	Magnitnaya	Hematite and Magnetite	64	8.00	0.02	0.01	500,000	1,000,000	2,000,000	1,500,000	4,500,000	—
El Algarrobo Cia. Acero del Pacífico	38 km E. of Guacolda	Kiruna	Magnetite and Hematite	64	5.50	0.15	0.05	1,200,000	50,000,000	30,000,000	40,000,000	120,000,000	—
Cristales	69 km N. of Cruz Grande	Kiruna	Hematite and Magnetite	64	4.00	0.02	0.40	—	5,000,000	5,000,000	5,000,000	15,000,000	—
Bandurria and others La Suerte, Hematita Cerro Negro	60 km E. of tide-water	Kiruna	Hematite	60	6.00	0.02	0.01	1,120,000	5,000,000	20,000,000	25,000,000	50,000,000	—
El Cheñar I.I.G. (Government-owned)	60 km N. of Vallemar	Magnitnaya	Magnetite and Hematite	60	6.00	0.01		—	—	—	—	—	200,000,000
El Pleita	30 km N.E. of Cruz Grande	Kiruna	Hematite and Magnetite	60	3.50	0.17	0.02	—	2,00,0000	3,000,000	5,000,000	10,000,000	—
El Tofo Bethlehem Chile Iron Mines	29 km E. of Cruz Grande	Kiruna	Hematite and Magnetite	60	10.00	0.06	0.06	250,000	4,000,000	—	—	4,000,000	—
El Remoral Bethlehem Chile Iron Mines	36 km N. of Guayadan	Kiruna	Magnetite and Hematite	63	7.00	0.25	0.12	1,260,000	40,000,000	20,000,000	20,000,000	80,000,000	—

ANNEX III *(continued)*

Ore bodies	Location	Type	Mineral	Percentages Fe	SiO$_2$	P	S	Production 1962	Reserves Proven	Indicated	Calculated	Total	Potential resources
El Dorado													
Cia. Minera Santa Fe . .	110 km S.E. of Coquimbo	Kiruna	Hematite and Magnetite	64	4.00	0.05	0.20	550,000	2,000,000	2,500,000	—	4,500,000	—
Infieraille (several)	110 km S.E. of Coquimbo	Kiruna	Hematite and Magnetite	62	4.00	0.30	0.20	—	2,000,000	2,500,000	—	4,500,000	—
Various small ore bodies . .	80 km E. of tide-water	Kiruna	Hematite	60	4.50	0.01	0.02	1,000,000	3,000,000	2,000,000	2,000,000	7,000,000	—
Fortuna													
Development Corporation	120 km E. of Talca	Kiruna	Magnetite	60	8.00	0.01	0.80	—	—	1,400,000	3,600,000	5,000,000	—
Balún													
Cia. Mahuelbuta	80 km S. of Labu	Lake Superior	Taconite	40	35.00	0.02	0.03	—	—	—	—	—	500,000,000
Free ferriferous sands	San Antonio Chilco coast	Stratified	Magnetite	25	70.00	0.02	0.15	—	—	—	—	—	300,000,000
		TOTAL ESTIMATED ORE IN 1962						8,100,000	120,630,000	100,400,000	116,000,000	337,130,000	1,250,000,000

ANNEX IV

Colombia: iron ore resources and reserves

(In metric tons)

Ore bodies	Location	Type	Mineral	Percentages Fe	SiO$_2$	P	S	Production 1962	Reserves Proven	Indicated	Calculated	Total	Potential resources
Pas del Río	Chicanocha River Valley	Minette	Hematite (oolythe)	48	10	1.00	0.07	420,000	50,000,000	50,000,000	30,000,000	130,000,000	—
Medellín	Aburrá River Valley	Latherite	Limonite	45	15	0.00	0.07	—		2,000,000		2,000,000	—
Medellín	Aburrá River Valley	Latherite	Limonite	25	20	0.10	0.07	—					380,000,000
Cerro Matose	Uré River Valley	Latherite	Hematite and Magnetite	50	6	0.30	0.20	—	10,000,000	10,000,000	20,000,000	40,000,000	—
		TOTAL ESTIMATED ORE IN 1961						420,000	60,000,000	62,000,000	50,000,000	172,000,000	380,000,000

ANNEX V

Mexico: iron ore resources and reserves

(In metric tons)

Ore bodies	Location	Type	Mineral	Percentages				Production 1962	Reserves				Potential resources
				Fe	SiO_2	P	S		Proven	Indicated	Calculated	Total	
Cerro de Mercado	3 km N. of Durango	Kiruna	Hematite and Limonite	62	3.90	0.70	0.25	1,000,000	50,000,000	10,000,000,	10,000,000	70,000,000	—
La Perla	1 km S. of Tacubaya	Magnitnaya	Hematite	60	7.00	0.11	0.30	200,000	25,000,000	20,000,000	5,000,000	50,000,000	—
Santa Ursula	N.S. Fernando	—	Hematite	62	3.70	0.10	0.20	—	10,000,000	3,000,000	17,000,000	30,000,000	—
Various: Volcan, La Negra and Golondrina	Northern zone	—	Hematite	60	4.00	0.12	0.25	100,000	2,000,000	55,000,000	55,000,000	112,000,000	—
El Maney and others	Central zone	Magnitnaya	Hematite	65	12.60	0.10	0.20	—	62,000,000	35,000,000	34,000,000	131,000,000	—
Flutén	50 km from La Union	Magnitnaya	Hematite	63	3.50	0.05	0.08	—	400,000	50,000	—	450,000	—
Pihuano	40 km N. E. of Colina	Magnitnaya	Hematite	61	3.00	0.20	0.10	—	680,000	—	280,000	960,000	—
El Encino	18 km S. of Pihuano	Magnitnaya	Hematite	60	4.50	0.32	0.13	—	6,500,000	5,000,000	5,000,000	16,500,000	—
Las Truchas group	9 km from Playa Asul	Magnitnaya	Hematite	59	7.50	0.04	1.14	—	66,000,000	7,000,000	—	73,000,000	—
Senitua	30 km N.W. of Sola de vega	Magnitnaya	Hematite	65	1.70	0.03	0.37	—	12,000,000	8,000,000	10,000,000	30,000,000	—
Various: Sol y Luna, Aquita and Chulla	Central zone	Magnitnaya	Hematite	60	4.00	0.12	0.20	—	5,000,000	5,000,000	50,000,000	60,000,000	—
		TOTAL ESTIMATED ORE IN 1961						1,300,000	239,580,000	148,050,000	186,280,000	573,910,000	—

ANNEX VI

Peru: iron ore resources and reserves

(In metric tons)

Ore bodies	Location	Type	Mineral	Percentages				Production 1962	Reserves				Potential resources
				Fe	SiO_2	P	S		Proven	Indicated	Calculated	Total	
Marcona	23 km from San Juan	Magnitnaya	Hematite and Limonite	60	4	0.18	0.40[a]	5,230,000	40,000,000	170,000,000	460,000,000	670,000,000	—
Jaurilla	14 km S. E. of Ica	Magnitnaya	Hematite and Magnetite	50	6	0.50	0.10		—	—	1,000,000	1,000,000	—
Huaoravilca	50 km from Huancayo	Bilbao	Hematite	60	4	0.10	0.60		—	32,000,000	32,000,000	64,000,000	—
Tambo Grande	45 km from Piura	Bilbao	Hematite	46	8	0.20	0.40		—	12,000,000	20,000,000	32,000,000	—
		TOTAL ESTIMATED ORE IN 1961						5,230,000	40,000,000	214,000,000	513,000,000	767,000,000	—

[a] Also contains 1.5 per cent copper.

ANNEX VII

Venezuela: iron ore resources and reserves

(In metric tons)

Ore bodies	Location	Type	Mineral	Percentages				Production 1962	Reserves				Potential resources
				Fe	SiO_2	P	S		Proven	Indicated	Calculated	Total	
Cerro Bolívar	85 km S. of Bolívar	Lake Superior	Hematite	62	0.70	0.15	0.01	11,060,000	653,000,000	533,000,000	500,000,000	1,686,000,000	—
El Pao	48 km S. of Palúa	Lake Superior	Hematite	64	0.30	0.03	0.03	2,140,000	92,000,000	150,000,000	—	242,000,000	—
Cuad. San Isidro (various)	90 km S. E.of Bolívar	Lake Superior	Hematite	60	3.00	0.15	0.01	—	563,000,000	267,000,000	—	830,000,000 [a]	780,000,000
María Luisa	65 km S. E.of Bolívar	Lake Superior	Hematite	64	0.90	0.15	0.01	—	—	150,000,000	—	150,000,000	—
Piacca	30 km S. of Los Castillos	Lake Superior	Itabirite	45	53.00	—	—	—	—	—	—	—	225,000,000
El Trueno	140 km S. of Bolívar	Lake Superior	Hematite	55	0.90	0.15	0.01	—	—	—	—	—	150,000,000
Las Grullas	40 km E. of El Pao	Lake Superior	Hematite	55	0.90	0.15	0.01	—	—	—	—	—	50,000,000
Los Castillos	30 km N. of Piacea	Lake Superior	Itabirite	45	50.00	—	—	—	—	—	—	—	20,000,000
	TOTAL ESTIMATED ORE IN 1961							13,200,000	1,308,000,000	1,000,000,000	500,000,000	2,908,000,000	1,225,000,000

[a] Contains 45 per cent Fe and 18 per cent SiO_2.

ANNEX VIII

Brazil: iron ore resources and reserves

(In metric tons)

Ore bodies	Location	Type	Mineral	Percentages				Production 1962	Reserves				Potential resources
				Fe	SiO_2	P	S		Proven	Indicated	Calculated	Total	
Minas Geraes (several)	320 km N.W. of Rio de Janeiro	Lake Superior	Hematite	66	0.52	0.03	0.01	10,242,000	1,146,000,000	—	950,000,000	2,096,000,000	
Minas Geraes (several)	320 km N.W. of Rio de Jáneiro	Lake Superior	Hematite	50	6.00	0.14	0.01	—	500,000,000	1,500,000,000	1,000,000,000	3,000,000,000	
Minas Geraes (several)	320 km N.W. of Rio de Janeiro	Lake Superior	Itabirite	35	2.00	?	?	—	5,000,000,000	—	5,000,000,000	10,000,000,000	18,000,000,000
Urucum	Bolivian frontier	Lake Superior	Itabirite [a]	55	10.00	0.11	0.01	24,000 [a]	300,000,000	—	—	300,000,000	10,000,000,000
Amapa	Mouth of the Amazon	Lake Superior	Itabirite	66	4.00	?	?		—	—	—	—	9,000,000
Bahia (several) . .	Santa Fe	Lake Superior	Itabirite	60	6.00	0.03	0.01	6,000	—	—	—	—	50,000,000
Sao Paulo (several)	Joquia-Registro	Massive	Magnetite	60	0.15	0.01	0.01	2,000	500,000	3,000,000	—	3,500,000	—
Parana	Rio Branco	Massive	Magnetite	60	0.20	0.02	0.01	172,000	11,600,000	—	10,000,000	21,600,000	—
TOTAL ESTIMATED ORE IN 1961								10,446,000	6,958,100,000	1,503,000,000	6,960,000,000	15,421,100,000	28,059,000,000

[a] Includes reserves of 62 per cent Fe, 4.5 per cent SiO_2 and 0.16 per cent P, plus 0.04 per cent S; and resources containing 50 per cent Fe, 15 per cent SiO_2 and 0.02 per cent P, plus 0.04 per cent S; and 45 per cent manganese beds, in production.