STUDIES OF RAW MATERIALS IN JAPANESE CONTROLLED TERRITORY

Iron ores in Manchuria

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IRON ORES OF MANCHURIA

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Figure 1. Map of Manchutia showing location of iron deposits.

Figure 2. Takushan Mine, Anshan district.

Figure 3. Map of iron and coal deposits of Tunghua Province.

MANCHURIA

INTRODUCTION

Manchurian iron deposits are principally confined to Fengtien and Tunghua provinces of southern Manchuria. A large number of deposits are known and Japanese geologists have estimated total reserves running into thousands of millions of tons. Most of the Manchurian ores, however, are of low grade and require concentration before being sent to the blast furnaces, and, although there are also bodies of higher grade ore, the average ore, as mined in Manchuria, requires between 2½ and 3 tons of ore for a ton of pig iron.

Up to 1938, at least, the Manchurian blast furnaces at Penhsihu and Anshan consumed the entire iron ore production. Consequently, pig iron, but not ore, was exported to Japan.

Information on recent developments is very meager. In 1937 probably about 2,000,000 tons of ore was produced, all from deposits in Fengtien. Probably about 70% of this was lean ore. This production could easily be increased, as the ore bodies are large and easily mined, but to produce 1,500,000 tons of pig iron, which is less than the 1939 capacity of the two major plants, would require between 3,500,000 and 4,500,000 tons of ore. Import of Yangtze ore into Manchuria in 1940 may indicate some difficulty in meeting an expanded pig iron production from domestic ore. On the other hand, recent operations of the Kyowa Mines Co. (not known to have any furnaces in Manchuria) suggests the possibility that deposits in Fengtien, probably chiefly rich ore, are being mined for export to Japan. Such ore would be exported from Yingchow, Dairen, or ports near the mouth of Yalu River.

The recently developed deposits in Tunghua Province may provide a larger proportion of export ore to Japan. The ore is both low and high grade and, in part, has a high manganese content, which would be desirable for Japanese furnaces. Shipments were made in 1939 but the amount is unknown. Blast furnaces in this region were expected to be in operation by the end of 1941 but construction may have been deferred, and all the ore sent to Japan. If so, there may be a considerable supply, possibly to the extent of a million tons a year, of ore that contains more than 35% iron and 5 to 10% manganese and of ore of over 50% iron, but without manganese. This might be exported either from Chinnanpo or Seishin and may undergo preliminary smelting in a rotary kiln to drive off the contained water and form a low grade manganiferous pig iron ("luppe") which could be shipped to Japan with a considerable saving in tonnage.

GRADE OF ORE AND CONCENTRATION

The great bulk of the ore is of low grade, mostly 30 to 40 percent iron and is high in silica. Although ores having this iron content can be smelted efficiently if they are low in silica and high in lime, like those of Lorraine and Alabama, siliceous ores should have an iron content of at least 45% and preferably 50%. It is, therefore, necessary to concentrate almost all Manchurian ores before smelting, thus adding considerably to the cost of the pig iron. The adaptibility of the ores to concentration differs in different deposits according to the ore minerals present and the size of the particles. The Miaoerhkou deposit, which furnishes ore to the Penhsihu iron works, is largely magnetite and concentration is relatively simple, involving only fine crushing, concentration with a magnetic separator, and briquetting. The Anshan ores, on the other hand, contain very finely divided hematite with individual grains less than .004 inch (0.1 mm.) in diameter. It is therefore necessary to first crush the ore to 0.4 inch size, heat in a reducing atmosphere of coal gas until it is magnetized, crush again to .004 inch size, concentrate with the magnetic separator, and then sinter the dust to obtain particles of sufficient size for charging in the blast furnace.

Japanese reports of the deposits now being developed in the Tungpientao region include in their estimates of ore reserves large tonnages of material containing 35 to 40% iron and 3 to 10% manganese. In these ores the principal iron mineral is the silicate chamosite. Calcining might raise the iron content to 40 or 45% and the relatively high manganese content would make it a desirable ore.

PRODUCTION

Iron ore
(1,000 metric tons)

	Anshan[a]	Miaoerhkou[a]	Total[a]	Lean Ore[b]	Rich Ore[b]	Total[b]
1931	817	147	964	673	251	924
1932	888	153	1,041	743	237	980
1933	916	260	1,176	770	328	1,098
1934	950	235	1,185	740	394	1,134
1935				986	492	1,478
1936				1,325	579	1,904
1937 (1st half)						1,029

a/ Geol. Survey of China, Special Report No. 5.
b/ Manchuria Yearbook, p. 495, 1941.

Pig iron
(1,000 metric tons)

				Ratio - pig iron to ore		
	Anshan	Penhsihu	Total	Anshan	Penhsihu	Total
1931a/	269	66	335	.33	.45	.35
1932a/	287	81	368	.32	.53	.35
1933a/	318	116	434	.35	.45	.37
1934a/	322	153	475	.34	.65	.43
1935b/	457	151	608			.41
1936b/	473	160	633			.33
1937b/	(1st half)		732			.36?

a/ Geol. Survey of China, Special Report No. 5.
b/ Manchuria Yearbook, p. 495, 1941.

No two sets of production figures agree in detail. Those given above are probably of about the right order of magnitude and the ratio of ore to pig iron gives at least an approximation of the average grade of the ore.

SHIPMENTS

Information is not adequate for any close estimate of possible shipments.

The logical ports for ore and pig iron shipment from Fengtien Province would be Dairen, Yingchow, and Antung or Tashito. There are, however, rail connections with Korea and shipments could be made from Korean ports with saving of shipping distance at the expense of a longer rail haul. The prevailing low grade of the ores suggests that pig iron rather than ore will be exported, but the fact that the Kyowa Company, owning no blast furnaces in Manchuria, was developing several deposits in 1940 may indicate that ore also will be shipped.

If the blast furnaces in Tunghua Province, expected to be completed in 1941, are now in operation, much of the output of these mines may be shipped as pig iron, in part manganiferous. If not, there is probably export of a considerable tonnage of ore, perhaps in part reduced to sponge iron (luppe) before shipment. The railroads as shown on available maps make Chinnanpo the logical port for Chitaokou ore. Ore from Talitsukou would require the construction of a short line in the Yalu valley (about 70 miles) either to Chian for Chinnanpo or to Keizonchin for Seishin.

Province (according to Fig. 1)	District	Estimated Mineable Reserve (metric tons)	Known Annual Capacity (metric tons)	Probable Potential Annual Capacity (metric tons)	Transportation	Limiting Conditions of Output	Average Iron Content of Ore	Other Constituents	Mining Method	Vulnerability	Remarks	Peferences
Fengtien	Anshan	400,000,000 mostly lean ore. 2,000,000 to 4,000,000 tons rich ore.	1,000,000 (lean ore); 200,000 (rich ore).	2,000,000 lean ore; 200,000 rich ore.	Deposits only a few miles from Anshan. Export (probably entirely as pig iron) presumably from Dairen (180 miles, railroad) or Yingchow.	Lean ore requires complex treatment before smelting. Rich ore only in small bodies and relatively costly to mine.	Lean ore 33 to 45%. Rich ore 54% or better.	Lean ore: high silica, 35 to 49%; low phosphorus, 0.03%; low sulfur, 0.02%. Rich ore: silica, 11 to 22%; generally low phosphorus and sulfur, but in part sulfur as high as 0.31%.	Lean ore: open cut and gravity incline. Rich ore: open cut and tunnels.	Anshan is principal metallurgical center of Manchuria. Concentrating plant, blast furnaces, coke ovens, steel works, cement plant etc. all highly vulnerable. See U. S. G. S. report - coal, pp. 81-82. Mines not vulnerable.	Mines may be operating on a smaller scale than formerly, and lean ore for plant derived from Kunchangling. Possibly part of rich ore used is imported from Yangtze. Probably no export of ore. Pig iron capacity at Anshan would allow considerable export of pig iron or steel.	Tegengren, F. R. Mem. Geol. Survey China, Ser. A, No. 2, pp. 112-119, 1923. Murakami, H. Geology of the Anshan Iron Mine district. South Manchuria Ry. Co., Dairen, 1921. Manchuria Yearbook, 1941.
Fengtien	Kungchangling	Lean ore: over 300,000,000. Rich ore: 2,300,000.	No data.	2,000,000?	Railroad 40 miles to Anshan.	Lean ore requires concentration but may be more easily treated than Anshan.	Lean ore: about 37%. Rich ore: 60 to 69%.	Lean ore: silica 36 to 38%, phosphorus 0.03%, sulfur 0.01 to 0.06%. Rich ore: silica 10%, phosphorus 0.01 to 0.05%, sulfur about 0.30%.	Probably open cut.	Probably not vulnerable.	Together with Anshan, supplies ore for Showa steel works. On basis of 1,500,000 tons pig iron production the two districts together would have to furnish about 4,000,000 tons ore a year.	Tegengren, pp. 109-112. Manchuria Yearbook, 1941.
Fengtien	Miaoerhkou	Lean ore: 70,000,000, of which 1,400,000 is rich ore.	260,000.	500,000 or more.	2,000 ft. gravity train, and 1½ mile branch railroad to main line at Nanten, 25 miles S. of Penhsihu. Export (as pig iron) probably from Yalu ports.	Lean ore is magnetite and more easily concentrated than Anshan. Production could be increased by opening additional workings.	Lean ore: about 34%.	Lean ore: silica 40 to 50%, phosphorus about 0.02%, Rich ore: silica 5%, phosphorus 0.04%, sulfur 0.12 to 0.80%, manganese 0.37%. Ore is friable and in part breaks to dust.	Open cut and tunnels.	Gravity incline vulnerable but replaceable. Concentrating plant at Nanten. Blast furnaces, coke ovens etc. at Penhsihu. See U. S. G. S. report - coal, p. 81.	Penhsihu Iron Works produces a special low phosphorus pig iron which is exported to Japan.	Tegengren, pp. 102-109. Manchuria Yearbook, 1941.
Fengtien	Waitoushan	150,000,000.	No data.	?	20 miles NW. of Penhsihu, near main line of railroad.	Reported chiefly lean ore but easily concentrated.	Rich ore 54%. Lean ore 30% and over.	Rich ore: silica 19.7%, phosphorus 0.04%, sulfur 0.31%, manganese 0.86%.	Probably open cut.	Probably not vulnerable.	Supplies ore to Penhsihu Iron Works. Ore body reported to be 35 ft. thick and traceable for 1,300 ft.	Manchuria Yearbook, 1941. Far East Yearbook, 1941. Inouye, K. The iron ores of Southern Manchuria, C. R. Int. Geol. Congr. Stockholm, 1912, p. 285.
Fengtien	Takoyan	?	No data.	?	Probably near Penhsihu.	?	No data.	?	No data.	Probably not vulnerable.	Supplies ore to Penhsihu Iron Works.	Manchuria Yearbook, 1941.
Fengtien	Hsifeng (Kyowa Iron Mines Co.)	?	No data.	?	About 90 miles NNE. of Mukden, 25 miles from main railroad line. About 300 miles by rail from Antung.	?	60 to 65%.	?	No data.	?	Mining began in 1940. Ore may be intended for export.	Manchuria Yearbook, 1941.
Fengtien	Kaiyuan (Kyowa Iron Mines Co.)	?	No data.	?	About 65 miles NE. of Mukden, near main railroad line.	?	Nearly 60%.	?	No data.	?	Mining began in 1940. Possibly for export.	Manchuria Yearbook, 1941.
Fengtien	Chiaotou (Kyowa Iron Mines Co.)	?	No data.	?	Near Mukden - Dairen Ry. about 200 miles from Dairen.	?	No data.	?	No data.	?	Mining began in 1940. Possibly for export.	Manchuria Yearbook, 1941.
Fengtien	Hsukiatun (Kyowa Iron Mines Co.)	?	No data.	?	Near Mukden - Dairen Ry. about 100 miles from Dairen.	?	No data.	?	No data.	?	Mining began in 1940. Possibly for export.	Manchuria Yearbook, 1941.
Fengtien	Wutaokou (Kyowa Iron Mines Co.)	?	No data.	?	Locality not identified.	?	No data.	?	No data.	?	Mining began in 1940. Possibly for export.	Manchuria Yearbook, 1941.
Fengtien	Huapiyu	?	No data.	?	50 miles E. of Mukden about 20 miles from railroad.	Large scale production would require several tunnels.	65%.	Unknown, but possibly high in sulfur.	Shaft and tunnel.	Not vulnerable.	Native mining in 1921. No record of modern mining.	Tegengren, pp. 122-123.
Tunghua	Talitzu (Talitsukou)	70,000,000, total 3,400,000 mineable by open cut and tunnel.	No data.	800,000?	About 60 miles to main line railway at Chian, which is about 240 miles from Chinnanpo. Export also possible via Keizonchin, 70 miles to E., where rail connection (180 miles) to Seishin.	Probably largely lean ores. Two thickest beds 26 and 17 ft. possibly mineable by open cut.	Lean chamosite ore: 26.8 to 33.1%. Lean siliceous ore: 26.8 to 38.7%. Rich ore: 51.0 to 56.2%.	Lean chamosite ore: silica 13.0 to 19.6%, phosphorus trace, sulfur 0.05 to 0.24%, manganese 5.4 to 8.1%. Lean siliceous ore: silica 41.2 to 57.0%, negligible phosphorus and sulfur, manganese 0.2%. Rich ore: silica 6.6 to 25.8%, negligible phosphorus, sulfur and manganese.	Open cut.	Possible concentrator or calcining plant. Power from Yalu dam.	The chamosite ore is sufficiently high in manganese to be desirable for export to Japan in spite of its low iron content. Calcining would raise grade to 30 to 42%. Ore from this district and Chitaokou to be used in local iron works expected to be in operation in 1941. Mining began in 1939. Expected production in 1940: 1,200,000 tons of which 200,000 chamosite, to be later raised to 1,300,000 in all.	Inouye, K. The iron ores of Southern Manchuria. Int. Geol. Congr. Stockholm, 1912, pp. 277-287. Tegengren, pp. 126-127. Saito, R. Economic geology of environs of the Talitsukou iron mines. Bull. Geol. Inst. So. Manch. Ry., No. 91, 1937. Manchuria Yearbook, 1941.
Tunghua	Chitaokou	9,700,000, total 3,400,000 mineable by open cut and tunnel.	No data.	200,000?	Favorably situated for export from Chinnanpo (about 200 miles).	Probably less favorable for large scale production than Talitzu because of irregularity of ore bodies.	51 to 53%.	5% manganese, silica, sulfur, and phosphorus unknown.	Open cut or tunnel.	Not vulnerable.	High iron and manganese content if as reported would make this ore very desirable for export to Japan. Mining began in 1939 and some ore was shipped to Japan.	Manchuria Yearbook, 1941.
Tunghua	Laoling	100,000,000?	No data.	?	About 15 miles NW. of Linkiang, and 60 miles NE. of Chian. No known rail connection.	?	30 to 40%.	Contains 5 to 12% manganese.	No data.	Probably not vulnerable. Iron works (at Ehrtaokiang) may now be in operation.	Apparently lower grade than other Tunghua deposits but high manganese content may make it a desirable export ore. Had been explored in 1939 but no mining at that time.	Manchuria Yearbook, 1941. Metall und Erz. Heft 24, 1939, p. 592.
Tunghua	Antzuho	?	No data.	?	About 45 miles east of railway at Meihokou.	Probably thin bed only.	60%.	Reported good grade of magnetite.	No data.	Not vulnerable.	No large scale mining in 1939.	Tegengren, pp. 134-135.

Compiled by U. S. Geological Survey.

PRINCIPAL DISTRICTS

The salient facts of the principal active and potentially active deposits are summarized in the accompanying table. Some information is available for other deposits but as they appear to be either inactive or undeveloped they are not included.

In the following notes all information on recent operations is derived from Japanese propaganda sources and may not be reliable.

The locations of the known deposits are shown in Figure 1, which map has been followed for provincial boundaries.

Fengtien Province

Anshan: The ore deposits of the Anshan district[1] largely supply the Showa Steel Works at Anshan. The ore outcrops on the crests and sides of a group of 6 hills which rise to 1,000 feet above the plain in a rough semicircle east of the main line of the railway and 4 to 8 miles from Anshan.

The ore is, for the most part, very low grade (36 to 45% iron) and high in silica (35 to 49%) but is low in phosphorus (0.02 to 0.06) and sulfur (trace to 0.05). With the low grade ore are thin bands of higher grade material that ranges from 54 to 62% iron and in places has as much as 66%. This ore contains 11 to 22% silica and is also low in phosphorus and sulfur. Concentrates from the low grade ore contain between 53 and 62% iron and 9 to 18% silica. Rich ore from the Yingtaoyuan mine, as mined in 1940, was reported to contain 54.4% iron, 19.7% silica, 0.04% phosphorus, 0.31% sulfur and 0.86% manganese[2].

Available reserves are large, estimated by Tegengren to be about 400 million tons in all, of which not more than 2 million tons constitute high grade ore. The low grade ore is mined from open cuts that have gravity inclines to the railroad level. The smaller bodies of higher grade ore were mined from tunnels, but the photograph, Figure 2, apparently taken in 1939, shows open-cut mining at the Takushan mine, which contains the principal high grade deposits.

As the iron mineral of the low grade ore is very finely divided hematite, a complex and expensive process of concentration is necessary.

1/ Tegengren, Mem. Geol. Survey of China, Series A, No. 2, pp. 112-119, 1923.
Murakami, H., Geology of the Anshan Iron Mine District, South Manchuria Railway Co., Dairen, 1921.

2/ Manchuria Yearbook, p. 494, 1941.

The Anshan (later Showa) Iron works was established in 1919. At that time the unsatisfactory nature of the low grade ores was not realized and attempts to smelt it directly were unsuccessful. Therefore, until 1926, when the concentrating process was established, almost all the production was from the high grade ore, at the rate of about 150,000 tons a year. In 1940[3] the proportion of low grade to high grade ore mined was said to be 7 to 1. The ratio of total ore to pig iron indicates an annual production of about 1,500,000 tons, including ore from the Kunchangling district, of which nearly 200,000 tons is high grade ore.

The reserve figures for Anshan high grade ore given in the Manchuria Yearbook[4] are 1.3 million tons hematite with 50 to 60% iron and 3.0 million tons magnetite with 60 to 68% iron. As no figures for low grade are given this may indicate that only high grade ores are now mined at Anshan whereas the more easily concentrated ores from Kunchangling supply the bulk of the low grade ore. It is possible that the easily mined reserves of high grade ore in the Anshan district may be approaching exhaustion.

An item of possible significance is the export of 84,000 tons of iron ore from the Yangtze to Dairen in 1940[5]. This may indicate that the Showa plant at Anshan is finding it difficult to meet its expanded production plans from local ore.

Costs of mining in 1923 were estimated at Yen 1.50 for the low grade ore mined by open cut and Yen 5 to 6 for the high grade. Railroad freight on pig iron was reported to be Yuan 7.00 per ton to Dairen in 1940. A canal connecting Anshan and Yingchow was planned.

Kungchangling: The Kunchangling district[6] about 25 miles southeast of Liaoyang and midway between the Dairen and Antung railways, was being explored at the time of Tegengren's study. At that time it was expected to export the richest ore to Japan. There was, however, no production from the deposit until it was purchased in 1933 by the Showa Steel Works and a railroad built to Anshan[7]. The deposit supplies part of the ore used in the Anshan furnaces but no production figures are available. The ore may be more amenable to concentration that that of Anshan, and if so would compensate for the 40 mile rail haul.

3/ Manchuria Yearbook, 1941, Hsinking, 1940.
4/ Op. cit., p. 494.
5/ Foreign Minerals Quarterly, p. 25, Oct., 1941.
6/ Tegengren, op. cit., pp. 109-112.
7/ Contemporary Manchuria, Jan., 1938.

There are several large ore bodies favorably situated for open cut mining on the crest and flanks of a group of ridges which rise to 2,500 feet above the valley. Ore reserves were estimated by Tegengren at more than 268 million tons of which 2.3 million tons was of high grade. A recent Japanese estimate gives reserves as 377 million tons hematite ore having about 40% iron and 456 million tons magnetite ore that contains 35% iron[8]. The iron ore has a thickness varying from 100 feet (30 m.) to 1,000 feet (300 m.) or more. High grade ore bodies containing over 50% iron are of limited occurrence, and occur in lenses from a few feet to 65 feet (20 m.) in thickness[9].

Preliminary sampling of the low grade ore showed an iron content ranging from 29 to 41%, high silica (41 to 58%), moderate phosphorus (0.02 to 0.09%), and variable sulfur (0.09 to 0.21%). More recent and probably more representative samples of lean ore give iron 36.2 to 38.2%, silica 46.0 to 48.1%, phosphorus 0.01 to 0.02%, and sulfur 0.01 to 0.06%[10]. The iron content of the high grade ore ranges from 60 to 69% with not over 10% silica. Phosphorus is low (0.01 to 0.05%) but sulfur is rather high (about 0.30%).

Miaoerhkou: The Miaoerhkou deposit[11] which furnishes ore for the Penhsihu iron works, is about 2 miles east of Nanfeng (Nanten) station on the Mukden-Antung railway, about 25 miles south of Penhsihu. The ore crops out on the crest of a ridge which, at the mine, has an altitude of more than 2,800 feet.

The deposit consists mainly of low grade ore with streaks of rich ore, but is more favorable for mining than Anshan, for the rich ore is in larger and more regular bodies, up to 50 feet in width, and the ore mineral is magnetite, which is susceptible to direct magnetic concentration. The width of the ore body as a whole ranges from nearly 300 feet (90 m.) to nearly 600 feet (180 m.).

The low grade ore has an iron content of 34 to 38%, 40 to 50% silica, low phosphorus (0.005-0.05), and variable sulfur (trace to 0.4). The rich ore is a nearly pure magnetite containing from 65 up to 71% iron and not over 5% silica; phosphorus is low (0.02-0.05) but parts of the rich ore bodies contain an objectionable amount of sulfur, up to 0.8%, though mostly the sulfur content is below 0.3%. A recent analysis[12] gives rich ore: iron 64.0, silica 6.2, phosphorus 0.02,

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8/ Manchoukuo Yearbook, p. 494, 1941.
9/ Ichimura, T., On the iron formation and associated high grade ore bodies of the Kung-Chang Ling, Chosen Kogyo Kai-Shi, vol. 5, no. 8, pp. 1-25, 1922. English abstract in Jap. Jour. Geol. and Geog., vol. 2, no. 1, 1923.
10/ Ichimura, T., Geological notes on the Mozan iron bearing district, Chosen, Mem. Taihoku Univ., Geology, No. 6, p. 95, 1933.
11/ Tegengren, op. cit., pp. 102-109.
12/ Manchuria Yearbook, p. 494, 1941.

sulfur 0.12, and manganese 0.37; lean ore: iron 33.6, silica 50.9, phosphorus 0.05, sulfur 0.03. The rich ore is very friable and from 10 to 20% breaks to a fine dust which requires briquetting before going to the blast furnaces. The Penhsihu blast furnaces produce a special low phosphorus pig iron, which is exported to Japan.

Reserves were estimated in 1922 at 70 million tons of which 1.4 million tons was high grade ore. At that time mining was essentially restricted to the high grade ore which was then being mined at the rate of about 100,000 tons a year. There is no information as to mining practice in recent years since the production has increased, but, as the ore is easily concentrated it is probable that both high grade and lean ore are mined.

Mining in 1922 was from tunnels, the lowest 730 feet below the highest point of the outcrop. From the tunnel mouth a gravity tram more than 2,000 feet long led to ore bins at the head of a 1½ mile branch railroad, which joined the main line at Nanfeng (Nantan). The concentrating plant was at Nanfeng but the briquetting plant at Penhsihu. Costs at that time were estimated at $Chinese 5 to 6 per ton. If both lean and rich ore are now mined open cut mining would be possible.

Waitoushan[13]: The Waitoushan deposit, 20 miles northwest of Penhsihu, also supplies ore to the Penhsihu furnaces. The ore body is described as being 35 feet thick and extending for 1,300 feet. The ore is mostly lean, 30% or more of iron though there is a little rich ore having about 50% iron. The ore mineral is magnetite, so concentration is relatively simple. The Penshihu furnaces also get ore from Takoyan (locally not identified).

Other deposits of lean ore in the vicinity of Penhsihu have been described by Tegengren[14].

Huapiyu: The Huapiyu deposit[15], about 50 miles east of Mukden contains high grade ore (65.5% iron) but probably has a rather high sulfur content. The thickness ranges from 6 to 16 feet but the outcrop has been traced for a distance of 3,500 feet. It was formerly mined by native methods and as far as known there has been no modern mining. If not too high in sulfur it could probably supply a fair tonnage of high grade ore. The deposit is in hilly country and is

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13/ Inouye, C. R. Int. Geol. Cong., Stockholm, p. 285, 1912.
Manchuria Yearbook, p. 500, 1941.
14/ Tegengren, p. 108.
15/ Tegengren, pp. 132-133.

mineable by tunnel. Other deposits in the neighborhood have similar ore but are smaller and of lower grade.

Kyowa Iron Mines Co.: Several iron deposits were being developed by this company in 1940[16] but nothing is known as to production or reserves.

The Hsifeng deposit, about 90 miles NNE. of Mukden, was reported to contain 50 to 65% iron; the ore of the Kaiyuan deposit near the Mukden-Harbin Railway, about 65 miles NNE. of Mukden, was reported to contain nearly 60% iron. Other deposits belonging to this company are at Chiaotou, near the Mukden-Antung Railway, about 50 miles SSE. of Mukden, Hsukiatun near the Mukden-Dairen Railway about 130 miles from Mukden and 100 miles from Dairen, and Wutaokou (locality not identified).

It is possible that this company is mining high grade ore for export.

Kuotishan: A large deposit of lean ore (about 30% iron) at Kuotishan 2½ miles north of Tashihchiao, the junction of the branch line to Yingchow, is estimated by Tegengren to contain 1.3 million tons[17]. Apparently there has been no recent mining.

Tunghua Province

The mountainous country along the north bank of the Yalu River near Chian contains deposits of coal and iron ore which were being actively developed in 1939. This is commonly referred to as the Tungpientao region. Little specific information is available.

The deposits have long been known but were not mined except on a very small scale during the Chinese regime. Following the Japanese occupation there was a preliminary investigation of the region in 1933 but "disturbed social conditions" prevented detailed exploration of the deposits until 1936 and 1937 when a complete study of the region was made, and the Tungpientao Development Company organized in the following year to undertake extensive operations.

According to the Manchuria Yearbook[18]: "Provided it can be completely supplies in the near future with the necessary machinery

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16/ Manchuria Yearbook, p. 500, 1941.
17/ Tegengren, p. 119-121.
18/ Manchuria Yearbook, p. 490, 1941.

and materials for mining, the entire plant of this company will soon be working under high pressure. According to the expansion program of the company, the mining and sale of iron ores and coals deposited in Tunghua Province and the manufacturing and sale of iron are to be commenced in the first period, and an iron foundry with an annual productive capacity of 500,000 metric tons is to be constructed for the manufacture of pig iron, with all necessary equipment installed by the end of the second period. The part of the program to be completed in the 1939 fiscal year includes the mining of coals to the amount of 150,000 metric tons in the Tiehchangtzu coal-field, 150,000 metric tons at Wutaokiang, 50,000 metric tons at Pataokiang and 50,000 metric tons at Yentungkou, making a total of 400,000 metric tons; the mining of iron ores to the total of 200,000 metric tons at Talitzukou and 150,000 metric tons at Chitaokou making a total of 350,000 metric tons; and a gigantic construction plan in which transformer stations, machine-manufacturing factories and other facilities are to be erected with various mining plants, while foundations for the establishment of iron mills, coke manufacturing and coal cleaning plants, the central electric station and the central machine-manufacturing factory will be laid at Erhtaokiang".

These deposits, like others in Manchuria, consist of mixed lean and rich ores, but in addition to the usual ore minerals, magnetite and hematite, part of the ore consists of manganiferous chamosite. The composition is variable but the maximum iron content is probably about 35 to 40% with 5 to 10% manganese. Calcining might raise the iron content to 40 or 45% and the manganese in proportion. Apparently only the higher grade iron ores and the ores with highest manganese were to be mined until iron works with a capacity of 500,000 tons had been installed. "With the completion of equipment installment, studies on processing of poor grade ores will be conducted"[19].

Talitsukou (Talitzu): The Talitsukou deposit[20] is a short distance north of the Yalu River and about 8 miles WSW. from Linkiang. The nearest rail points in 1939 were Chian 60 miles (96 km.) SW. and Keizanchin 70 miles (110 km.) to the east. Both these points are on

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19/ Contemporary Manchuria, Milestones of Progress, p. 7, Jan., 1939.

20/ Inouye, K., The iron ores of southern Manchuria, C. R. XI Int. Geol. Cong., pp. 277-287, Stockholm, 1912.
Tegengren, op. cit., pp. 126-127.
Saito, R., Economic geology environs of the Talitsukou iron mines, Bull. Geol. Inst. So. Manch. Ry., No. 9L, Dec., 1937 (in Japanese, translated in part in U. S. Geological Survey, contains analyses, but little specific information).
Manchuria Yearbook, 1941, Hsinking, 1940.

the Yalu River and railroad construction in either direction would not be difficult. The large output planned for 1940 and later, suggests that one or both rail connections have been made.

The deposit consists of 4 beds of ore 26, 17, 5, and 4 feet thick, The ore, is a mixture of hematite and chamosite. Reserves were estimated by Inouye, who first described the deposit, as at least 1.2 million tons of better than 50% grade. A recent figure, probably exaggerated, at least as to grade of ore, gives 71 million tons of 62.5% iron with 3.5% silica, 0.02% phosphorus and 0.02% sulfur[21], of which 34 million tons are above tunnel level[22]. Analyses given by Saito indicate three types of ore: (a) low grade, probably largely chamosite, with 26.8 to 33.1 iron, negligible phosphorus, moderate sulfur (0.05 to 0.24%) but a high content of manganese (5.4 to 8.1%); (b) a very siliceous low grade ore 26.8 to 38.7% iron, 41.2 to 57.0% silica, very low phosphorus and sulfur and only a little manganese (0.2%); (c) high grade ore, 51.0 to 56.2% iron, 6.6 to 25.8% silica, very low sulfur and phosphorus and low manganese (under 0.03%).

According to the 5 year plan, production from the Talitsukuo deposit in 1940 was expected to reach 1,200,000 tons of which 200,000 would be chamosite. The manganese content of the chamosite makes it a desirable ore in spite of its low iron content. Mining began in 1939 and it was hoped to reach a production of 200,000 tons in that year.

Chitaokou: The Chitaokou deposit is close to the railroad and near Chian (Tsian)[23] and is similar in general character to that of Talitsukou but the ore bodies are less regular. The ore occurs in two beds about 600 feet apart. The lower is 45 feet thick and about 600 feet long but the ore is in places banded with low grade or barren rock. The upper bed is 18 feet thick and 1,200 feet long.

Various conflicting statements have been made as to reserves and grade of ore; the most conservative gives 9.7 million tons of which 3.3 million tons is above valley level. The grade is fairly high, 51 to 53% iron and up to 5% manganese[24]. Open cut mining began in

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21/ Manchuria, p. 1297, July 15, 1939.
22/ Morizaki, M., The development of Tungpientao's mineral resources, Manchoukuo Current Topics, pp. 36, Oct., 1940.
23/ Note discrepancy in position as given in Figures 1 and 3.
24/ Tungpientao Development Co., Manchuria, p. 1297, July 15, 1939.

Aug. 1939 and it was hoped to produce 150,000 tons in that year and continue an annual production of 300,000 tons.

Laoling: The Laoling deposit, about 15 miles northwest of Linkiang has been explored but was not producing in 1939. The ore consists of limonite and has an iron content of 30 to 40% but it has a relatively high percentage of manganese (5 to 12%)25/. Mining operations were planned but had not begun in 1940. The proposed site for the iron furnaces is close to the deposit.

SOURCES OF INFORMATION

The best available description of Manchurian ore deposits, particularly Fengtien Province, is the Chinese Geological Survey report of 192326/. For the Tunghua deposits, however, this quotes a still earlier Japanese report27/. Since the Japanese occupation, almost all technical publications have been in Japanese, and the English abstracts that accompany a few of the papers are almost completely lacking in information of direct economic value. Publications in English from such sources as Contemporary Manchuria, Japan-Manchoukuo Yearbook etc. do not appear to be completely reliable. No production figures have been published since 1937.

Some confusion is introduced by the fact that Chinese names used in the earlier reports differ from the ones used in the later Japanese publications.

25/ Metall. und Erz., Jg. 36, Heft. 24, p. 592, 1939.
26/ Tegengren, F. R., The iron ores and iron industry of China, Mem. Geol. Survey of China, Ser. A., No. 2, pp. 97-137, 1923.
27/ Inouye, K., The iron ores of southern Manchuria, C. R. Int. Geol. Cong., Stockholm, pp. 277-287, 1912.

Fig. 1

MAP OF MINERAL RESOURCES IN MANCHOUKUO

Scale 1:4,000,000

0 50 100 150 200 250 300 Km

- Boundary of Countries
- Boundary of "Sheng" (Province)
- Railways
- Railways under Construction
- × Coal
- □ Aluminium Shale
- + Iron
- △ Oil Shale
- ✡ Zinc and Lead
- ▽ Magnesite
- ⌗ Copper
- ⊙ Gold
- ⊙ Placer Gold

Names of mines under the M.I.D. Corporation's management are printed in red letter

Those managed by other concerns are printed in italics

0 50 100 200 Miles

SOVIET UNION

PROV. AMUR

JEWISH AUTO PROVINCE

OUTER MONGOLIA

MANCHOUKUO

HEILUNGKIANG

PEIAN

PINKIANG

KIRIN

HSINKING

MUTANKIANG

SANKIANG

TUNGAN

CHIENTAO

TUNGHUA

FENGTIEN

CHINCHOU

JEHOL

NORTH HSINGAN

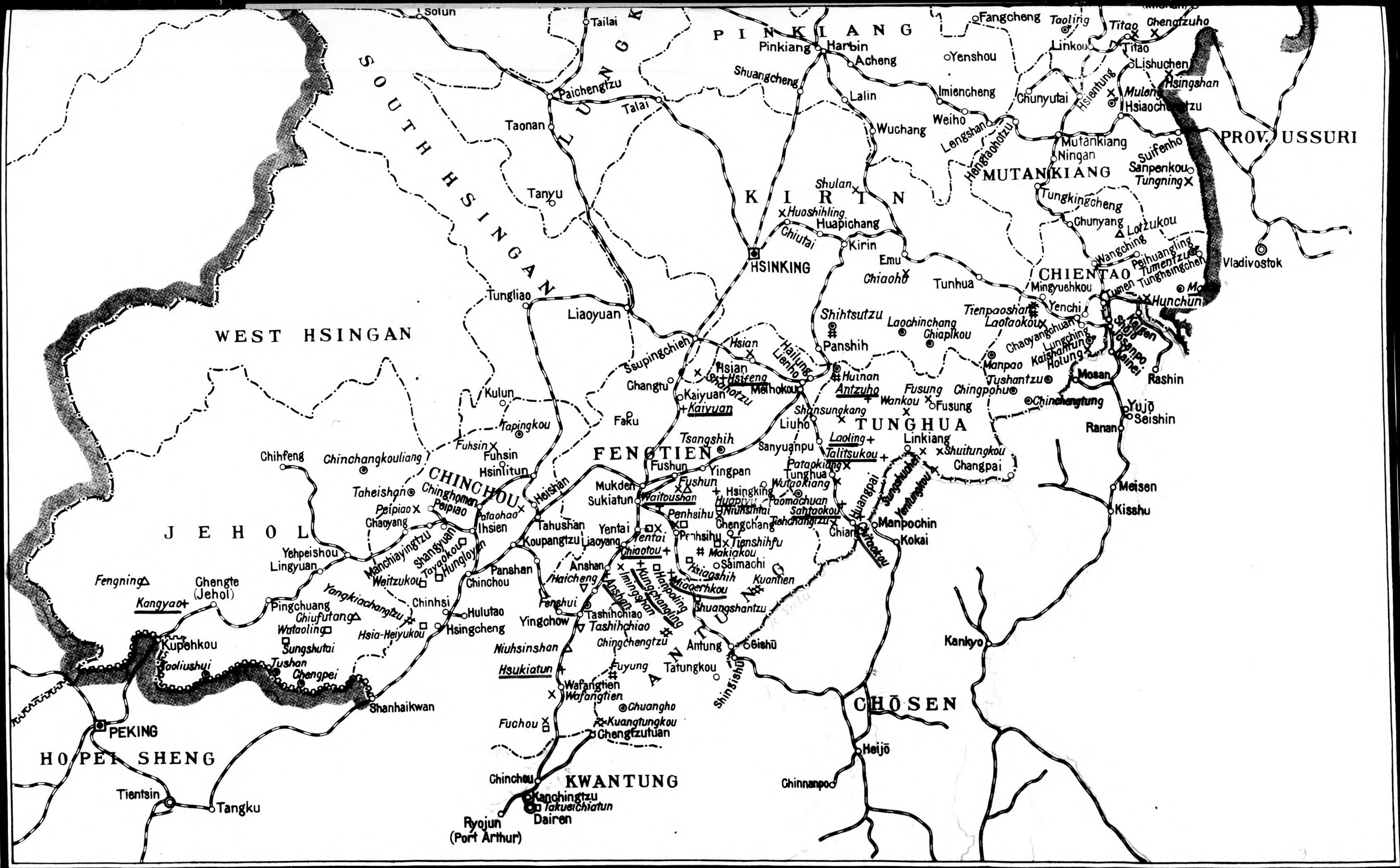
EAST HSINGAN

SOUTH HSINGAN

WEST HSINGAN

PROV. USSURI

Moho, Chikan, Talahan, Hsinlung, Sanfenchu, Heiho, Nichiuhoo, Manchouli, Chalainor, Hailar, Nunkiang, Peian, Kuantu, Wutunghoo, Hokang, Hsingshan, Chalantun, Ningnien, Tsitsihar, Angangki, Wenchuan, Shenshu, Ohiamuszu, Liushuhotzu, Ihuapo, Hulin, Yinglanchen, Sanhsing, Hsiaoshihtou, Suihua, Solun, Tailai, Pinkiang, Harbin, Acheng, Yenshou, Fangcheng, Taoling, Titao, Linkou, Lishuchen, Hsingshan, Tungan (Mishan), Chengtzuho, Shuangcheng, Paichengtzu, Talai, Taonan, Lalin, Imiencheng, Weiho, Chunyutai, Hsientung, Muleng, Hsiaochengtzu, Wuchang, Lengshan, Hengtaohotzu, Mutankiang, Ningan, Suifenho, Sanpenkou, Tungning, Tungkingcheng, Chunyang, Laotzukou, Wangching, Peihuangling, Tumentzu, Tumen, Tunghsingchen, Vladivostok, Tanyu, Shulan, Huoshihling, Huapichang, Chiutai, Kirin, Emu, Chiaoho, Tunhua, Mingyuehkou, Yenchi, Hunchun, Tienpaoshan, Laotaokou, Shihtsutzu, Laochinchang, Chiaplkou, Chaoyangchuan, Lungching, Kaishantun, Holung, Yongsan, Yongsanpo, Rashin, Mosan, Yujo, Seishin, Ranan, Meisen, Kisshu, Manpo, Tushantzu, Chingpohu, Chinchengtung, Wankou, Fusung, Antzuha, Huinan, Liuho, Shansungkang, Sanyuanpu, Laoling, Jalitsukou, Linkiang, Shuitungkou, Changpai, Pataokiang, Tunghua, Mutaokiang, Huapiyu, Paomachuan, Sahtaokou, Tiehchangtzu, Manpochin, Kokai, Chian, Huangpai, Sungshuchen, Yentungkou, Hsingking, Nunsimai, Penhsihu, Chengchang, Tienshihfu, Makiakou, Saimachi, Hsiaoshih, Kuantien, Mukden, Sukiatun, Waitoushan, Fushun, Yingpan, Tsangshih, Faku, Kaiyuan, Changtu, Hsifengkotzu, Meihokou, Hsian, Hailung, Lianho, Ssupingchieh, Panshih, Shihtsutzu, Laochinchang, Chiaplkou, Tapingkou, Kulun, Fuhsin, Hsinlitun, Chihfeng, Chinchangkouliang, Taheishan, Chinghoman, Peipiao, Chaoyang, Ihsien, Pataohao, Heishan, Tahushan, Koupangtzu, Liaoyang, Yentai, Chiaotou, Anshan, Haicheng, Iminge, Kungchuling, Hanposhan, Miaoerhkou, Yehpeishou, Lingyuan, Manchiayingtzu, Weitzukou, Shangyuan, Tayaokou, Hunglojan, Panshan, Chinchou, Fengning, Chengte, Tungliao, Liaoyuan, Taonan, Talai, Paichengtzu, Shuangcheng, Nunkiang, Peian, Ningnien, Tsitsihar, Angangki, Chalantun, Wenchuan, Solun, Tailai, Suihua, Shenshu, Hailar, Manchouli, Chalainor, Heiho, Nichiuhoo, Talahan, Hsinlung, Sanfenchu, Moho, Chikan



The Heavy Industry of Manchoukuo , Tokyo 1940

Fig. 2 IRON ORES IN MANCHURIA

1939

TAKUSHAN MINE, ANSHAN DISTRICT

East Asia Economic News, July 1939

Fig. 3 IRON ORES IN MANCHURIA

TUNGPIENTAO (TUNGHUASHENG PROVINCE) IRON AND COAL RESOURCES.

Eisen und Gold in Tungpientau (Provinz Tunghasheng) • Mines de fer et de charbon à Toungpientao (Tounghouasheng)