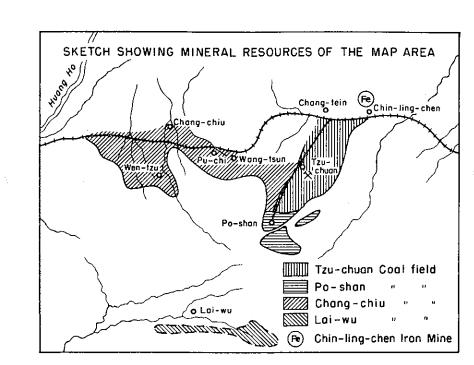
GEOLOGIC COLUMN AND UNIT DESCRIPTIONS

			GEOLOGIC COLUMN AND UNIT DESCRIPTIONS	
AGE	E ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION	
QUATERNARY	Alluvium	Sand, gravel and silt; thickness 10 meters	Arluvium, consisting of sand, gravel and silt, is widely distributed in plains and valleys. The vast delta plain of the Huang Ho in the northern map area is generally covered by secondary loess transported by the Huang Ho.	
QUATE	Diluvium	Loess, sand, gravel, silt, conglomerate and red clay; thickness 20 to 30 m	Diluvium consists chiefly of primary loess of aeolian and fluvio-aeolian origin, accompanied by gravel and lenticular conglomerate of limestone pebbles near the base. Red clay is locally found at the base. Diluvium in the Huang Ho delta plain is composed of silt and sand and is probably several hundred meters thick.	
TERTIARY	Kuanchuang formation	Shale, sandstone and conglomerate; thickness less than 1,700 m	The Kuanchuang formation consists of loosely consolidated shale, sandstone and conglomerate composed of pebbles of red quartzite, limestone, syenite, diorite and other igneous rocks. In the Lai-wu valley the formation is 1,670 m thick (T'AN, 1923) and contains gastropods and mammalian bones that indicate Eocene age.	
	Diorite	DISCONFORMITY Quartz diorite, syenite and gabbro NTRUSIVE CONFACT	Diorite includes quartz diorite, syenite, and gabbroic rocks. The quartz diorite in the district of Changtien (張店) is the ore-bringer of the Chin-ling-chen iron mine where the iron deposits are distributed in the contact between the quartz diorite and the Ordovician limestone. The diorite is thought to be a facies of the Cretaceous granite which occurs out of the map area.	
	Mengyin series	Sandstone, conglomerate and shale; thickness less than 1,300 m	The Mengyin series consists of green sandstone accompanied by tuffaceous conglomerate and purplish brown shale in the upper part; green shale and greenish sandy shale in the middle; gray to greenish or brownish shaly sandstone and green hard coarse-grained sandstone in the lower part. According to T'AN (1923) the series contains reptilian remains, plants, and fresh water mollusks. It was assigned to the Lower Cretaceous by GRABAU (1928). The thickness was estimated at 380 to 1,240 m.	
MESOZOIC	Andesite	UNCONFORMITY Lava flows, agglomerate and tuff	Andesite, resting upon or apparently intruding the Jurassic deposits, consists of lava flows, lava agglomerate, and tuff. The andesite is gray or reddish gray and contains phenocrysts which are mostly feldspars. The agglomerate and the tuff are essentially composed of andesitic matter.	
	Porphyrite	Diabase porphyrite and dolerite	Porphyrite includes intrusive sheets and dikes of diabase porphyrite and dolerite, mainly injected into the Jurassic Red Sandstone formation (Mju) and the coal-bearing formation (Mj).	_
	Jurassic Red Sandstone formation	Sandstone, shale and conglomerate; thickness 400 m	The Jurassic Red Sandstone formation conformably overlies the coal-bearing formation. It consists chiefly of reddish sandstone, intercalated with green and violet shale, white sandstone, and conglomerate.	
	Jurassic coal-bearing formation	Sandstone, shale and coal; thickness less than 170 m	The Jurassic coal-bearing formation disconformably overlies the Permian-Triassic formation (Put), and is probably correlatable with the Ment'oukou formation (Upper Triassic?) in the hills west of Peking, and also with the Peipiao series of Jehol. It consists of white sandstone and greenish gray or dark gray shale, intercalated with two or three thin seams of unworkable coal.	
	Permian-Triassic formation	Quartzose sandstone, shale and fire clay; thickness 300 m	The Permian-Triassic formation conformably overlies the Permian-Carboniferous formation (Pup). (See Correlation chart.) It consists of yellowish white quartzose sandstone, with an alternation of variegated sandstone and shale in the lower part. Fire-clay (bed-A) occurs at the base.	1
PALEOZOIC	Permian-Carboniferous formation	Sandstone, shale, limestone, clay and coal; thickness more than 400 m	The Permian-Carboniferous formation consists, in descending order, of the Middle Permian "Tzuchuan series", the Lower Permian "Poshan series", the Upper Carboniferous "Chang-tien series", and the Middle Carboniferous "Changch'iu series" (ONUKI, 1951). (See Correlation Chart and Columnar Sections.) The Tzuchuan series is an inland deposit composed of an alternation of yellowish white or yellowish brown thick-bedded sandstone and shale. The upper half of the Tzuchuan series is called the Heishan formation, consisting of reddish rocks rarely containing thin coal seams and shale, which is partly workable as fire-clay; the lower half or the Rungshan formation is intercalated with the Upper coal group and two or three layers of limestone. In the Tzu-chuan coal mine seams B, C, and D of the Upper coal group have been worked. The Poshan series consists of alternately bedded sandstone and dark shale, the latter being predominant, and is intercalated with the Middle and Lower coal groups and two to four thin lenses of limestone. The total thickness of the Tzuchuan and the Poshan series is 350 m to 400 m, the lower 200 m of which contains coal. The Changtien series (Uralian?) and the Changch'iu series (Muscovian) are conformable, and the combined thickness seldom exceeds 70 m. Both series are composed of alternating sandstone and shale, lenticular limestone, and hard fire-clay (bed G, 5 to 10 m thick) near the base. Plant fossils contained in carbonaceous sandstone and shale are Lepidodendron oculis-felis, Calamites sp., Sigillaria sp., Stigmaria sp., Pecopteris arborescens, Cordaites principalis, Newropteris sp., Palaeopteris lanceolata, Collipterilium?, Annularia sp., etc. The Poshan series yields many fusulina and brachiopods including Peeudo-schwagerina princeps (EIREEN), Quarifusulina longissima (MOLLER), Schwagerina vulgaris var. (SCHELIWIEN), S. vulgaris var. globosa (SCHELIWIEN), S. valida (IEE), S. richthofeni (SCHELIWIEN), S. vulgaris var. globosa (SCHELIWIEN), S. valida (IEE), S. richthofeni (SCHELIWIEN), S. vu	
P4		Dolomite, limestone, argillaceous limestone and shale; thickness 850 m	The Ordovician formation of the Chi-nan area was formerly called the "Chinan limestone" by WILLIS and BLACKWELDER (1907) who estimated its thickness at 850 m. They divided the Chinan limestone into two parts; the lower part is a variable sequence of light-colored argillaceous limestone or dolomite and thin shales, and the upper part is a dark brown dolomitic limestone of fine texture occurring in massive strata. The compiler believes that this succession is uniform throughout the map area. On the basis of the paleontological study of the Ordovician formation near the Poshan coal field, OBATA (1951) assigned the age of the upper part to the Middle Ordovician and that of the lower part to the Lower Ordovician. Cephalopod fossils reported by OBATA include Armenoceras curvatum (GRABAU), A. murakamiii (KOBAYASHI), A. (Pararmenoceras) teicherti ENDO, A. richthofeni (FRECH), A. sondai ENDO, A. submarginale (GRABAU), A. hemiressleri OBATA, A. (Pararmenoceras) tani (GRABAU), A. (Shantungoceras) tateiwai KOBAYASHI, A. coulingi (GRABAU), A. elongatum ENDO, A. hatai ENDO, A. ressleri ENDO, Stereoplasmoceras actinoceriforme GRABAU, S. machiakouense GRABAU, S. pseudoseptatum GRABAU, Polydesmia peshanense (KOBAYASHI), P. canaliculata LORENZ, Stereoplasmocerina tofangoense KOBAYASHI, Cycloceras peitoutzense GRABAU, Hemipiloceras allipticum SHIMIZU & OBATA, Ormoceras (Parormoceras) takayamai (ENDO), Endoceras leei YU, Changkiuoceras shantungense SHIMIZU & OBATA, Robsonoceras amplum (KOBAYASHI), and Ellesmereoceras sp.	
	Cambrian formation	DISCONFORMITY? Limestone, shale and conglomerate; thickness more than 500 m	'The Cambrian formation consists in descending order of:1) the Upper Cambrian Ch'aumitien limestone, 2) the Middle Cambrian Kushan shale and Ch'anghsia limestone, and 3) the Lower Cambrian Mantou shale (WILLIS, 1907). The Ch'aumitien limestone, 180 m thick, consists of bluish gray limestone with intraformational limestone conglomerate; the Kushan shale, 15 m thick, consists of a green shale with thin shaly and conglomeratic limestone; the Ch'anghsia limestone, 150 m thick, consists of gray and frequently oblitic limestone especially in the lower part; and the Mant'ou shale, 175 m thick, consists mainly of reddish brown shale with some thin limestone near the bottom. No paleontologic study was made of the Cambrian formation in the map area.]
PRECAMBRIAN	Precambrian gneiss or Taishan complex	UNCONFORMITY Biotite granite gneiss and undifferentiated gneiss Column not drawn	The Taishan complex is chiefly gneisses of unknown origin and character, and biotite granite gneiss. Associated with them are such metamorphic schists as mica schist, amphibolite, etc. All the metamorphics are intruded by granite, pegmatite, and gabbroic or dioritic rocks, which are relatively young, though most are probably Precambrian in age.	
	ľ	to scale		



ECONOMIC VALUE

Tron Chin-ling-chen (金額鎮) Iron Mine: The Mine office lies north of Chin-ling-chen station. The iron deposit was known since the age of Confucius. Germany acquired the mining concession in 1896, but the mine was not opened until 1919 when Japan took it over. In 1922 the mine returned to China according to the agreement reached at the Washington Conference. Next year the mine was put under the management of the Lu-ta (魯大) Kung-ssu, a Sino-Japanese company, and operation was suspended. In 1942 it was taken over by the Japanese army, and the Nippon Kokan Co. worked it until the end of World War II. The hematite-magnetite ore deposit is distributed in the contact between diorite and Ordovician limestone. Six ore bodies were worked, which trend northeast and generally dip 40° to 50°. The ore shows 58.4% Fe, 23.62% Fe0, 57.90% Fe₂O₃, 0.24% Mn, 5.66% SiO₂, 1.009% S, 0.099% P, 0.127% Cu, 3.51% CaO, 0.003% As, and 0.67% Al₂O₃. The iron ore reserves are about 3 million tons. Production was 32,506 t in 1942, 250,093 t in 1943, and 145,942 t in 1944. About one half of the output was shipped from T'sing-tao to Japan and Korea.

Tzu-chuan Coal Mine: - Main office of the coal mine lies 65 km southeast of Tzu-chuan station. Germany opened the mine in 1904, and began to work in 1913 when World War I broke out. The mine was later placed under the Japanese army supervision. In 1923 the management was succeeded by the Sino-Japanese Lu-ta Kung-ssu, as the result of the Washington Conference. With the outbreak of the Sino-Japanese Indicent in 1932, Japanese employees of the mine were evacuated. Next year the Japanese army took possession of the mine which was named the Tzu-chuan Coal Mine. The Permian coal-measures are intercalated with 11 coal seams, 6 of which in the Middle and Lower coal groups are workable. The coal seams generally strike N 45° E and dip 7-20° NW. The coal varies from medium-grade bituminous to anthracitic coal. Mean values of the proximate analyses are as follows: 1% H20, 12-14% volatile matter, 12-20% ash, 73-80% fixed carbon, 1.5% S, 7,000-8,500 cal heat value. Estimated coal reserves according to the coal mine are 780 million tons (estimation was made for the seams of more than 0.45 m thick, and to the depth of 800 m from the ground surface). Annual productions were 471,000 t in 1935, 755,000 t in 1936, 465,170 t in 1937, 90,311 t in 1938, 552,000 t in 1939, 912,000 t in 1940, 1,325,000 t in 1941, 1,592,000 t in 1942, and 1,850,000 t in 1943.

Po-shan Coal Mines: - Coal had been worked around Po-shan since the end of the Tang dynasty to supply fuel for the ceramic industry. During the Ming dynasty the district was prosperous in the industries of glassmanufacturing, ceramics, lime calcination, etc. After the opening of the railway traffic (1904) the coal under the name of "Shantung Coal" was shipped to the districts along the Chingtao-Chinan Railway as far south as Shanghai. Small Chinese native pits had been numerous before the Sino-Japanese Incident, and no regular mining of deep-seated seams was made. In 1940 the Japanese authorities established the Po-shan Coal Mining Office at Po-shan, in order to promote mechanization and production. The office managed the following eight mines under direct and indirect control of Japan: Po-ta, Wang-shan, and Hei-shan, which were operated by the Japanese Shantung Mining Industrial Co.; Li-ta, Tung-ta, Po-ta, Fu-ta, and Yeh-shang, which were Sino-Japanese mines. The total coal reserves of these mines were estimated at 100 million tons, of which the workable amounts are 49.4 million tons (as of 1945). The coal is generally medium-grade bituminous, or anthracitic coal, belonging to the Lower and Middle Permian formations. The coal is similar to the Tzu-chuan coal, but the product of the Hei-shan mine is strongly coking. Annual production in the Po-shan district culminated in 1942 when the output attained 2.4 million tons. In 1941 a total of 577,834 tons were shipped to Japan, 355,125 tons to other territories under Japanese control, and 651,748 tons to Chinan.

Chang-ch'iu Coal Mine: - The Chang-ch'iu coal field before the Sino-Japanese Incident (1937) was mainly worked by the Chinese mines such as Chiu-hua and Kuan-chuang on loan from the Japanese Shantung Mining Industrial Co. In 1939 they were incorporated into the Chang-ch'iu Coal Mine. The Chiu-hua mine is south of Pu-chi (普集), the Kuanchuang mine is in the eastern section of the coal field, and the Wantzu mine is in the western section. The first two mines are equipped with railroads. The Permian coal measures show a generally monoclinal structure, dipping 10° N. The coal reserves are unknown. The production in the fiscal year 1940 was 248,500 tons and in 1941 was 267,723 tons.

Lai-wu Coal Mine: - The Lai-wu coal field extends east-west for a distance of 30 km. The area west of a N-S fault passing through Yengchuang (顔莊) shows a synclinal structure, whereas the area east of it is monoclinal. Chinese worked the coal for more than a half a century. After the Sino-Japanese incident (1937) the Japanese Nittetsu Mining Co. carried out test drilling at Lai-wu (1939) and at Anshan-chuang (1941). Although plans for regular exploitation were made, the termination of war failed to materialize them. According to the Nittetsu Co., a seam of 1.75 m thick in the middle coal group, and five seams with a total thickness of 4.75 m (each being more than 50 cm thick) in the lower coal group are workable. The total coal reserves were estimated at 330 million tons. The output for 1942 and 1943 was about 15 thousand tons each year.

Cambro-Ordovician limestone west of Chin-ling-chen (金嶺鎮) was quarried for the North China Cement Co. which was established in 1944.

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CORRELATION CHART OF THE STRATIGRAPHY IN THE TZUCHUAN-POSHAN-CHANGCHIU COAL-FIELDS

Willis* 1907	T'an, H. C. 1923			Wang, C.C. 1932	Lee	Lee, J. S. 1939		WATANABE, H. 1924		KAW	ADA 937	ONUKI, Y 1951		, Y. 51	This map										
system	ssic	(Red	ni series 8 green tone fm.)	Jura-Cretaceous Red Sandstone	Sant'ai series						Mesozoic		Sar	ntai series	Jurassic Red Sandstone formatio (Mju)	4:0- []									
Hsintai sys	Jura	Shangkuenlun series (Mesozoic Coal fm.)		Lower Jurassic Coal series	Shangkunlun series		Hsintai system				Meso		Kue	nlun series	Jurassic coal-bearin formation (Mj)	ng	Jurassic								
unknown	assic	Hsiakuenlun series (Red sandstone fm.)		Triassic ? Hsiakunlun serles		(//////////////////////////////////////		·		Permo- Triossic		Fengfuangshan series		Permian-Triassic		Triassic									
WWW	Tric					shih eries		Takueishan formation		Permo-Triassic formation		UE	U	series	Hsiangfuho formation Takueishan	formation (Put)		} }							
			U	Permian and Permo-Triassic yellow shale fm.	se	eishan eries								Nanting	fm. Wanshan fm.	A-bed Fireclay		Permian							
system					Measure					stem	, ,	U			Permian	м	Tzuchuan series	Hei-shan fm.	Permian-	U.	Реттіал				
Poshan sy									Coal M	l l	Permo-Carboniferous	Poshan series		shan sy	ure	M	Permo-Carboniferous	formation		101	Tzuc	Hung-shan fm.	Carboniferous formation	M	Per
. Bo						Paleazoic		Coal Measure, and			Po	Measure	M	Permo			L	Pos	hon series	(Pup)		8			
								Pale		Carboniferous	series pchiu es			Coal	{	erous	ion	erous	U		gtien series	or Coal Measure		iferou	
			L		Penchi s	Changchiu series			L	Carboniferous	formation	Corboniferous	M	Changchiu series	U. fm. M. fm.			Carboniferous							

* W. Willis & E. Blackwelder

COLUMNAR SECTIONS SHOWING THE PERMIAN COAL GROUPS

OF THE CHANG-CHIU, TZU-CHUAN AND PO-SHAN COAL-FIELDS

Cha	ang-chiu Coal-field	·	Tzu	-chuan Coal-fiel	d	Po-shan	Coal-field	
interval (m)	Seam thickness Co (m)	oal seam no.	Interval (m)	Seam thickness (m)	Coal seam no.	Seam Interval thickness (m) (m)	Coal seam name	1 .
6.6 6.6 13.2	0.18 0.3 0.18 0-0.6 0.15 0.3		15.1	0.20	2 为二行 2 为二行 3 为三行 4 为四行	36.0 1.5 2.0 1.5 1.5	Shuang-hsing Hsiao-hei-shih Tan-miao Hei-shih(Hsia-shih) Chia-kang	双介 双黑石 炭苗 黑石(鍛石) 夹鋼
11.9	0.3~0.9	67	51.2	Group		2.5	(Lo-chiu?)	(羅 球?)
31.7			11.4 5.1 18.0	0.40 e 0.30 e' COD-8eOB NIQQIE COD-8eOB		1.0	Hsiao-huang-shih-tan	小黄心灰
42.9	0.6~2.4 — —	 8	33.3	_	6 为六行 7 才七行	1.0-3.0	Hui-shih-tan Ta-huang-shih-tan	灰石炭大黄石炭
	0.6~l,5	9		dnoi5 = 1.50~2.20 F F	8	1.0	Ku-hsing-tan yü-hsing-chien-miao yü-hsing-tan	結 性炭油 性占苗油 性 炭
11.2 2.6	0.9~I.5 — — — 0.9~I.2 — —	- 10 11	16.5 	1.50~2.20 F 0.70 G 0.50 H 0.60 I 1.30 I	10	48.0 4.0 2.0-40 3.0-5.0	Hsiao-shih-tan Ta-shih-tan	小 石 炭 大 石 炭
5.9	0.3	12 13	1	Lower		2.0	Hsia-shih-tan	鐵石炭