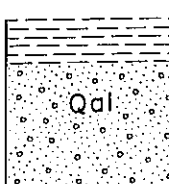
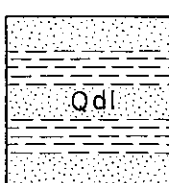

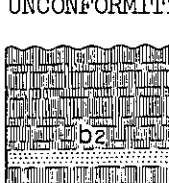
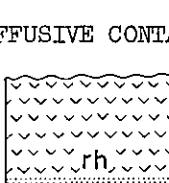
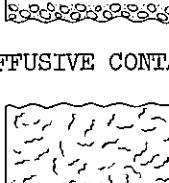
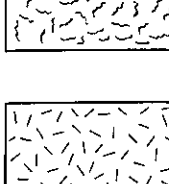
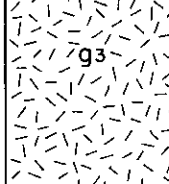
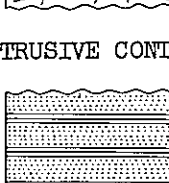


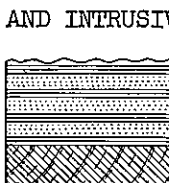


GEOLOGIC COLUMN AND UNIT DESCRIPTION

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION	ECONOMIC VALUE	REFERENCES	
QUATERNARY	Alluvium	 Sand, gravel and clay; thickness less than 15 meters	Alluvium, consisting of sand, gravel and clay, is distributed in the drainage basins of the Nen Chiang (嫩江), the Ya-lu Ho (雅魯河) and their tributaries. It covers flood plains and low terrace remnants, and is less than 15 m thick. Along the Nen Chiang where numerous playas are found, the alluvial deposit consists of silt and clay of aeolian origin and fine-grained sand of fluviolacustrine origin. The deposit near the mouth of the Ya-lu Ho forms an alluvial fan. Along the Ya-lu Ho and its tributaries the deposit consists of sand, gravel and clay; pebbles of the gravel are rhyolite, granite and quartz porphyry.		Geological Institute, South Manchuria Railway Co., 1938, Geological map of Manchuria, scale 1:1,000,000.	
	Diluvium	 Qdl, silty sand and clay; thickness unknown	Diluvium (Qdl) consists of aeolian-lacustrine silty sand and loessic clay.		HATCHO, Torao, 1926, Geology and mineral resources along the route Tao-nan -- Cha-lai-no-erh -- Man-chou-li (洮南-查爾諾爾-滿洲里): Unpub. rept., Geol. Inst., S. Manchuria Ry. Co.	
		 Qdg, gravel, sand and sandy clay; thickness more than 100 m	Diluvium (Qdg) is a fluvial deposit, consisting of gravel, sand and sandy clay. It covers high terrace remnants or occurs sporadically as inliers in the vast flood plains. The deposit is generally coarse-grained and cross-bedded, and is considered an uplifted delta deposit fringing the east margin of the Ta-hsing-an-ling Range. Animal fossils, such as rhinoceros and mammoth tusks, were found in the Pleistocene deposit 5 km southwest of Fu-la-erh-chi (福祿池), so the deposit is correlated with the Kulsungun (庫倫屯) formation of the Ha-erh-pin district. Drillholes in the flood plain of the Nen Chiang revealed the following sequences in descending order (Prefix numbers refer to drillhole sites on map): (1) T'ang-ch'i-h-t'un (湯池屯): very fine sand (31.62 m), sandy clay (2 m), fine sand (19.32 m), sandy clay (3.33 m), fine sand (21.85 m), sandy gravel (9.63 m). (2) Ang-ang-ch'i (昂昂倉): gravel and sand (13.23 m), fine sand (4.93 m), sandy clay (3.05 m), fine sand (19.66 m), sandy clay (2.13 m), coarse gravel (9.55 m). (3) Ch'i-ch'i-ha-erh (齊齊哈爾): coarse sand and gravel (28.3 m), clay (3 m), fine sand (3 m), sand and gravel (21.3 m), fine sand (3.3 m), sand and gravel (28.8 m). (4) Hui-tzu-fang (回子房): fine sandy clay (6 m), fine sand (16 m), coarse sand and gravel (3 m). (5) Wen-ku-ta (溫庫塔): sand and gravel (1.5 m), fine sand (3.9 m), gravel (3.7 m).		HIRAI, Keis5, 1935, Study on soils in Manchoukuo: Kyushu Imp. Univ. Agricultural Dept. OKADA, Shigemitsu, 1955, Iron zone along the eastern margin of the Ta-hsing-an-ling, in Geologic activity in post-war Manchuria: Unpub. rept.	
TERTIARY	Neogene basalt	 Olivine basalt, tuffaceous sandstone and breccia; thickness 10 to 100 m	The Neogene basalt extends intermittently to the north, passing through Ta-p'ing-kou (太平溝). It is a pitch-black, hard, compact, fine-grained olivine basalt showing remarkable columnar joints, and is associated with tuffaceous sandstone and breccia. The rock at Iao-fan-chia (老范家) is porous and amygdaloidal. The rock 6 km north of Ching-hsing (興寧) consists of fine-grained feldspar phenocrysts in a black groundmass. The basalt, which erupted on a large scale probably during the Miocene epoch, now remains as a caprock due to uplift and erosion.	<u>Building stone</u> The basalt 4 km northwest of Kan-nan (甘南) is quarried as building stone and for civil engineering works.	OZAKI, Hiroshi, 1938, Reconnaissance report on the route Tao-nan -- A-erh-shan (洮南-阿爾山) hot spring: Unpub. rept., Geol. Inst., S. Manchuria Ry. Co.	
	Cretaceous rhyolite	 Rhyolite, tuffaceous sandstone and conglomerate; thickness more than 300 m	The Cretaceous rhyolite in the western half of the map area consists of rhyolite, tuff, tuffaceous sandstone and conglomerate containing pebbles of diorite porphyry. The rhyolite is generally grayish white, contains phenocrysts of idiomorphic quartz, and shows a fluidal structure. The rock near Pi-li-t'u (皮里吐) contains pyrite and shows columnar and platy joints. In the northwestern corner of the map area, only the upper part is exposed, consisting of light red to grayish black rhyolite locally associated with trachyte. The flow of the Cretaceous rhyolite is probably more than 300 m thick.		SAITO, Rinji, compiler, 1940, Geological map of Manchuria and adjacent areas, scale 1:3,000,000: Manchoukuo Geol. Inst.	
MESOZOIC	Quartz porphyry	 Quartz porphyry, granite porphyry and diorite porphyry	Quartz porphyry in association with granite porphyry and some diorite porphyry is believed to be an acidic marginal facies of the Cretaceous granite (g ₃) which is known as the "Mongolian batholith" of Early Cretaceous age. The rock near Shih-chia-nu (石家奴) along the Ha-ta-han Ho (哈達河) grades gradually into the Cretaceous granite.		SHIKAMA, Tokio, 1951, The Quaternary period of Manchuria, in Geology and mineral resources of the Far East, Manchuria, III-10: Comp. Comm. Geology and Mineral Res. Far East, Tokyo Geog. Soc.	
	Cretaceous granite	 Biotite granite, hornblende-biotite granite, graphic granite, syenite porphyry, granodiorite, felsitic granite and gneissose granite	The Cretaceous granite, sporadically exposed in the northwestern part of the map area, is biotite granite characterized by tabular joints. Its friable texture suggests a marginal facies of granite proper. It occurs as laccoliths which solidified at rather shallow depth. A pinkish medium-grained hornblende-biotite granite, constituting the low terrace 5 km west of Ch'eng-chi-su-han (成吉思汗) station, rests obviously upon the Upper Paleozoic formation (Pup). Granite laccoliths are also found near Nien-tzu-shan (念珠山), Li-san-tien (李三店), Hsing-fa-t'un (興發屯) and Cha-lan-t'un (查蘭屯). The rock near Otatsuoro and Cha-lan-t'un is a pinkish biotite granite, and that near Su-chia-shan (蘇家山) is a biotite granite grading into syenite. The Cretaceous granite includes graphic granite, syenite, syenite porphyry, granodiorite, diorite, felsitic granite intruded by aplite dikes, and locally gneissose granite. The Jurassic formation (Mj) and the Jurassic volcanic complex (Mjv) are penetrated and contactmetamorphosed by the granite, whereas the Cretaceous rhyolite remains mostly intact. Hence, the age of the granite intrusion is Lower Cretaceous, younger than the Jurassic formation and a little older than the Cretaceous rhyolite.	<u>Building stone</u> The granite 1 km north of Nien-tzu-shan is quarried as building stone and for civil engineering works.	USHIMARU, Shitaro, and others, 1937, Geology and geography of northern Manchuria: Geol. Inst., S. Manchuria Ry. Co.	
	Jurassic formation	 Shale, sandstone, conglomerate and coal; thickness less than 100 m	The Jurassic formation, less than 100 m thick, is exposed in the following places along the Ya-lu Ho and its tributaries. (1) The formation near Yao-kuan-yao (腰關腰) overlain by the Neogene basalt (b ₂) consists of gray to black hard shale accompanied by sandstone, conglomerate and thin coal seams. The formation strikes N 0° - 20° W and dips about 40° E. The coal seams lie 10 m below the ground surface. (2) The formation 2 km south of T'ai-p'ing-chuang (太平庄) is overlain by the alluvial deposit and extends to the west for a distance of 7 km. It consists of black shale and two or three thin seams of coal, and strikes W, dipping 10° S. (3) The formation 7 km northwest and 10 km southwest of T'ai-p'ing-chuang rests disconformably on the Jurassic volcanic complex (Mjv) and is overlain by the Cretaceous rhyolite (rh).		<u>Coal</u> The Jurassic coal near T'ai-p'ing-chuang and near Yao-kuan-yao was formerly worked. It is poor in both quality and reserves.	
	Jurassic volcanic complex (Greenstone complex)	 Diorite porphyry, andesite porphyry, diabase, propylite, dolerite, rhyolite, volcanic breccia, tuff and tuffaceous sandstone; thickness more than 500 m	The Jurassic volcanic complex is an intricate assemblage of dark green igneous extrusives and intrusives, namely, diorite porphyry, andesite porphyry, diabase, propylite, dolerite, black rhyolite, volcanic breccia, tuff and tuffaceous sandstone. These rocks have heretofore been collectively called "Porphyrite", or "Greenstone complex", because of a greenish tinge due to chloritization and propylitization. The complex was often mistaken for the Cretaceous andesite, the Neogene basalt, and even for the hornfels of the Permian formation which occurs in close association with the complex. The complex rests unconformably upon the Upper Paleozoic formation (Pup), and is overlain by the Jurassic formation (Mj), the Cretaceous rhyolite (rh) and the Cretaceous granite (g ₃). It is locally intruded by sheets of the Cretaceous granite as is seen in the hill east of Nien-tzu-shan.		<u>Iron</u> The so-called "Iron-ore zone", 40 km wide and 300 km long, zonally extends northward along the eastern margin of the Ta-hsing-an-ling through Li-san-tien. Magnetite is found in the vicinities of Wu-chia-wo-p'eng, Nan-su-chia-shan (南蘇家山) and Ma-an-shan. Hematite occurs near Nan-su-chia-shan and at Wu-tao-kou*, east of Su-tao-kou. Some other iron ores, occurring as deposits or as boulders, are sporadically distributed within the "Iron-ore zone". * Not shown on map.	
PALEOZOIC	Permian(?) formation	 Shale, hornfels, graywacke, clay slate, chert, conglomerate, phyllite, tuff and sandstone; thickness 250 m to 500 m	The Upper Paleozoic formation, probably Permian in age, is sporadically exposed in the following places: (1) The formation in the hills south of Otatsuoro consists of black shale and hornfels; it is about 250 m thick, strikes E and dips 70° - 80° N. (2) The formation between Li-san-tien and Hsu-chia (許家) consists of graywacke, clay slate, chert, hornfels, conglomerate, phyllite and acidic tuff. The graywacke is dark blue, hard and compact, intercalated with coarse-grained yellowish brown conglomeratic sandstone. The clay slate is blackish green to dark brown and locally grades into black shale. The chert is whitish and medium-grained, intercalated with alternating graywacke and slate. The strike is NE at Wu-chia-wo-p'eng (吳家窩棚), E-W at Chia-hu-ling (柴湖嶺) and NW at Ta-wa-lung-kou (太平嶺). The dip ranges from 20° to 90° S or N. (3) The formation at the base of the terraces 5 km west and 3 to 9 km southeast of Ch'eng-chi-su-han station consists of graywacke and arkosic sandstone. The formation is contactmetamorphosed in various degrees by the Cretaceous granite (g ₃). The total thickness of the formation is about 500 m.			
	Carboniferous formation	 Crystalline limestone, siliceous limestone, sandstone and clay slate; thickness more than 250 m	The Carboniferous formation, consisting of grayish white crystalline limestone intercalated with light blue siliceous limestone, sandstone and clay slate, is found in the following places: (1) The formation overlain conformably by the Permian (?) formation (Pup) is exposed in the hills south of Otatsuoro. It is 250 m thick, extends to the east for 8 km, strikes to the east, and dips 70° - 80° N. (2) Several sporadic lenses of limestone are found in the granite and in the greenstone in the hills south of Li-san-tien. They were cut from the Permian formation by the granite intrusion, and occur as xenoliths ranging from 5 m to 500 m in length. One of the lenses west of Ma-an-shan (馬鞍山) yields fossils including <i>Parafusulina</i> sp. (2 m in length), corals, crinoids and brachiopods. (3) The limestone near Ta-wa-lung-kou overlain by the Permian formation is 20 m thick, striking NW and dipping NE.	<u>Copper</u> Copper ore is found near Su-chia-shan.		
PROTEROZOIC	Precambrian(?) gneiss	 Granite gneiss	The granite gneiss in the hill 5 km northeast of Su-tao-kou (蘇桃口) is pinkish and fine-grained. It is penetrated by diorite porphyry of the Jurassic volcanic complex (Mjv) and by the Cretaceous granite (g ₃), and may be Early Paleozoic or Precambrian in age.	<u>Limestone</u> The lenticular limestone, 20 m thick, near Wan-lung-kou is quarried and calcined for lime.		

(Column not drawn to scale)