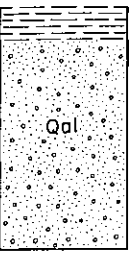
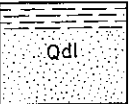


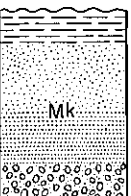
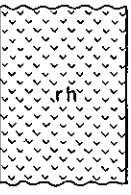

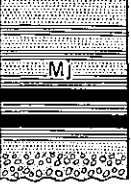



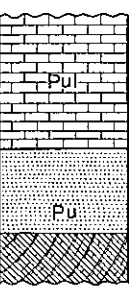
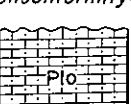
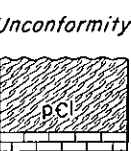


GEOLOGIC COLUMN AND UNIT DESCRIPTIONS

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION	REFERENCES
CENOZOIC	Alluvium	 Sand, gravel and clay; thickness more than 10 m	Alluvium is a terrestrial deposit, accumulated by the present rivers, and consists of sand, gravel and clay. It is widely distributed along the Yin-ma Ho [阴麻河], I-tung Ho [伊通河], Hsin-kai Ho [欣凯河], Tung-liao Ho [通辽河], Chai-ho Ho [柴河], Shuang-yang Ho [双阳河], Ku-shan Ho [库山河], Yang-shu Ho [杨舒河], Tu-tan Ho [杜坦河], Erh-tao Ho [额涛河] and San-tao Ho [三套河]. At the proposed dam site of Shih-tou-kou-shan [石透沟山], about 7.5 km east-northeast of Ch'ang-ch'un, along the Yin-ma Ho in the northeastern corner of the map area, the alluvium consists of an alternation of clay and sand, about 17 m in total thickness, and rests upon Permo-Carboniferous sandstone and black slate. At the proposed dam site of Yao-chai [姚寨], about 19 km south-southeast of Ch'ang-ch'un, along a tributary of the I-tung Ho, it consists of sand, about 7 m thick, and clay, about 3 m thick, and rests upon an alternation of Permo-Carboniferous sandstone and slate.	HADA, Jukichi, 1927, Geological maps of Manchuria, Kung-chu-ling [公巨岭] sheet, scale 1:400,000; Geol. Inst., S. Manchuria Ry. Co.
	Diluvium	 Silty sand and loessic clay; thickness 20 to 30 m	Diluvium can be divided into Qdl and Qdg.	1931, Geological maps of Manchuria, Peng-tien [彭天] sheet, scale 1:400,000; Geol. Inst., S. Manchuria Ry.-Co.
		 Sand, clay, gravel and loess; thickness 40 to 50 m	Qdg is composed of sand, clay, gravel and loess, constituting undulating plains about 150 m above sea level and 40 to 50 m in relative height. The gravel occurring near the base is composed of pebbles of basalt which is similar to the basalt in the Ta-tun [塔屯] and Pan-chia-tun [潘家屯] districts along the Hsien-ch'ang-ch'un Railway and in the I-tung district.	MORITA, Gijin, 1942, Geological problems of the Hsin-ching [新庆] area; Geol. Soc. Manchoukuo Jour., no. 96
		Unconformity		
		Neogene basalt	 Olivine basalt; thickness 20 to 70 m or more	The Neogene basalt is olivine basalt that may have been erupted before the Pleistocene and after the Cretaceous. It is found in such volcanoes as Ping-ling Shan [平岭山] 281 m above sea level, 2 km west of Ta-tun station, Ping-ting Shan [平亭山] 256 m high, and Chien Shan [谦山] 256 m high, about 3.7 km and 5 km south of Pan-chia-tun station respectively. It is also found at Ma-an Shan [马安山] 272 m high, about 3 km east of Hsueh-ch'ing station, Hsueh-chien Shan [薛谦山] 278 m high, about 9 km southeast of Ma-an Shan, Hsi-chien Shan [西谦山] 353 m, Ho-li-ching Shan [霍岭山] 351 m, and Ta-mu Shan [塔木山] 311 m, in the I-tung district. These volcanoes are flanked mostly by the gravelly Ta-tun Shan which erupted through the Cretaceous sediments. The basalt of Ping-ling Shan is dark reddish brown, abounds in vesicles from 0.1 to 10 cm in diameter, and occasionally contains chalcidony and calcite. Under a microscope, lath-shaped plagioclase shows a fibrous texture, and is in association with interstitial serpentine, iddingsite, chlorite and black iron mineral grains probably derived from olivine. The basalt of other localities mentioned above is black, dense, hard, and contains some olivine phenocrysts 1 to 2 mm in diameter. Under a microscope, the phenocrysts consist of olivine or olivine and labradorite. Olivine is colorless, hydromorphic or idiomorphic and is occasionally altered to yellowish green serpentine or reddish brown iddingsite along cracks. Labradorite is colorless, lath-shaped and shows albite-twinning. The groundmass consists of lath-shaped plagioclase, augite, and magnetite grains with interstitial glass. Sometimes the groundmass consists mainly of grayish black glass containing abundant acicular crystallites.
MESOZOIC	Chuntau formation	 Sand, clay, sandstone and conglomerate; thickness 250 to 500 m	The Cretaceous Chuntau formation [陈太组] is widely distributed on the northwest and southeast sides of the Ta-hai Shan [塔海山] a range which is 15 to 20 km wide and about 50 km long, extending from Ch'ang-ch'un in a southwesterly direction. The name Chuntau formation was given by J. HADA in 1927 who assigned it to Neogene, but in 1938 H. SAITO revised the age to Cretaceous. It is composed chiefly of reddish brown, coarse-grained sandstone and conglomerate. On the northwest side of the Ta-hai Shan range the formation strikes N 10 to 30° E and dips 5 to 10° SE. It rests unconformably upon granite (g), schist, Ordovician limestone (lo), rhyolite (rh) and Jurassic sediments (M), and is unconformably covered by the Diluvium. The thickness is 400 to 500 m. On the southeast side of the Ta-hai Shan range the formation strikes NE and dips 30 to 40° NW. It unconformably overlies granite (g) and the Precambrian basal system (P), or is faulted against the granite. The apparent thickness is about 250 m. The outcrop is about 70 km long and 2 to 5 km wide.	SAITO, Hideo, 1938, A consideration on the Chuntau formation; Manchoukuo Continental Sci. Research Inst., Bull. v. 2, no. 3.
		Unconformity		
	Rhyolite	 Biotite rhyolite and hornblende rhyolite	Rhyolite has intruded the Jurassic formation (M) and the Permo-Carboniferous formation (P), or erupted through the porphyrite (p) and the granite (g). It is older than the basalt (b) and the Cretaceous formation (M) and younger than the Jurassic formation (M) and porphyrite (p). The rhyolite in the Ch'ang-ch'un coal field, southeast of Ch'ang-ch'un, is grayish white biotite rhyolite, containing phenocrysts of quartz, sanidine and biotite. Quartz phenocrysts are colorless, transparent, idiomorphic or extremely corroded, and abound in irregular cracks. Sanidine is fresh, colorless and hydromorphic. The groundmass, consisting of quartz and feldspar microcline, shows a felsitic texture. The rhyolite in the eastern part of the map area is hornblende rhyolite, containing phenocrysts of quartz, orthoclase, oligoclase and hornblende, in the more or less glassy felsitic groundmass, and in places is nearly pitchstone.	1940, General view of the geology of Manchoukuo; Manchoukuo Geol. Inst., Bull. no. 100.
		Effusive contact		
	Porphyrite	 Biotite porphyrite, hornblende porphyrite and porphyrite-flow breccia	Porphyrite occurs as sills or dikes intruded into the granite (g) and the Jurassic (M) and Permo-Carboniferous (P) formations. It can be classified into three types: biotite porphyrite, hornblende porphyrite and porphyrite-flow breccia. The biotite porphyrite is found about 10 km southeast of Shuang-yang at Pan-chia-tun [潘家屯] and about 14 km south of Shuang-yang at Erh-tao-liang-tun [额涛梁屯]; the hornblende porphyrite occurs southeast of Ch'ang-ch'un; and the porphyrite-flow breccia lies east of Shuang-yang.	SAITO, Hideo, 1938, A consideration on the Chuntau formation; Manchoukuo Continental Sci. Research Inst., Bull. v. 2, no. 3.
		Intrusive and effusive contact		
	Jurassic formation	 Sandstone, shale, conglomerate and coal; thickness 400 m or more	The Jurassic formation constitutes small coal fields southeast of Ch'ang-ch'un, at Erh-tao-liang-tun, at Pan-chia-tun [潘家屯] about 30 km southeast of Shuang-yang, at Pan-la-shan [潘家山] about 13 km southeast of Hsueh-chien-tien station, and at Pan-la-shan-shan [潘家山山] [?]. It varies in thickness, strike and dip. It is intruded by, or is covered with, porphyrite, rhyolite or basalt, or is intercalated with sills of these rocks. The formation consists chiefly of friable sandstone intercalated with shale, conglomerate, buffaceous sandstone and thin coal seams. The formation in the Tao-chia-tun [桃夹屯] coal mine about 23 km southeast of Ch'ang-ch'un consists chiefly of alternating shale, sandstone and conglomerate, and strikes N 20° E and dips 30° to 35° NW. The following fossils are found in light gray, compact shale: <i>Elateolobus manchoukuoensis</i> (Tokoyama), <i>Podocarpus lanceolatus</i> (L. et H.), <i>Ginkgo sibirica</i> (Reer), <i>Baiera</i> cf. <i>gracilis</i> Bumb., <i>B. str. augustiloba</i> Reer, <i>Pilus nordenskioldi</i> Reer (?), <i>Czekanowskia rigida</i> Reer (?), and <i>Sphenopteris</i> (?) sp. The apparent thickness of the formation is 400 m or more.	UENO, Toshiro, 1933, Survey report of the ballast quarry at Ping-ting Shan near Pan-chia-tun; Geol. Inst., S. Manchuria Ry. Co. (unpublished).
	Unconformity			
Diorite	 Diorite	Diorite occurs in small areas as a marginal facies of granite, or penetrates the granite (g) or the Permo-Carboniferous Chilin formation (P). It is dark and medium-grained, composed of quartz, oligoclase, orthoclase and hornblende, in association with biotite, muscovite and small amounts of apatite, zircon, titanite, magnetite and ilmenite.	USHIMARU, Shitaro, 1938, Survey report of the ballast quarry at Ta-tun and Hsiao-tun [塔屯和小屯]; Geol. Inst., S. Manchuria Ry. Co. (unpublished).	
Pre-Jurassic granite	 Biotite granite, hornblende granite and muscovite granite	Granite is widely distributed in the mountainous regions. Light-colored, coarse-grained biotite granite is most common. Hornblende granite and muscovite granite are also found. Some granites in the map area locally present a gneissic texture. The age of the granite intrusion is considered to be younger than Permo-Carboniferous and older than Jurassic.		
Granite gneiss	 Granite gneiss	Granite gneiss occurs in the southern part of the granite region in the map area, and grades into the granite. The southern extension of the granite gneiss contains some Precambrian schists as xenoliths, or penetrates the schists as injection gneiss. The principal constituents of the granite gneiss are white or pink feldspar, quartz, hornblende and biotite.		
	Intrusive contact			
PALEOZOIC	Chilin formation	 Limestone Sandstone hornfels and slate hornfels Total thickness of the formation more than 1,000 m	The Permo-Carboniferous formation of the map area has been known as "Older Paleozoic" since 1908, but it is now believed to be younger Paleozoic. The formation was named Chilin formation by KAWADA in 1938, after the name of its type locality (see the Chi-lin sheet, No. 52-1). The Chilin formation is intruded by granite which has metamorphosed the rocks. The formation consists of greenish, hard and compact sandstone hornfels and slate hornfels, in association with limestone. The limestone occurs as lenses in the hornfels, but in the upper part of the formation it forms thick strata with a thickness 500 m or more. Some of the limestones are non-crystalline, but some others are highly crystalline and saccharoidal. KAWADA collected crinoid stems and corals from the limestone in 1938, and OKADA identified the following fossils in 1940: <i>Productus</i> sp., <i>Diphyphyllum</i> sp., <i>Plectambonites</i> sp., <i>Plectambonites</i> sp., <i>Plectambonites</i> sp., <i>Plectambonites</i> sp., and a <i>Syringopora</i> -like corals. These fossils suggest that the limestone is not younger than Lower Permian and not older than Carboniferous. The limestone east of Chi-lin (out of the map area) attains a thickness of about 1,000 m. The structure of the Permo-Carboniferous formation is not clear, but it strikes generally NE. A few folds occur parallel to the strike.	
	Ordovician formation	 Dolomitic limestone and flint; thickness about 300 m	The Ordovician formation occupies a wide area southeast of Kuo-chia-tien [郭家甸] station. It consists of bluish-gray, crystalline, dolomitic limestone frequently intercalated with thin layers of dark gray flint, and contains a number of poorly preserved crinoid stems. In places, the limestone is metamorphosed by granite intrusion and altered to white coarse-grained marble.	
PRECAMBRIAN	Wutai system	 Chlorite schist, talc schist, sericite schist, graphite schist and limestone; thickness more than 1,000 m	The Lower Precambrian formation consists of schists with lenticular limestones. Schists are chiefly chlorite schist, talc schist, sericite schist and graphite schist. Quartz-bearing schist is also found, though rarely. The thickness of the formation is not known owing to the disturbance of the strata, but it is apparently more than 1,000 m. The formation is assigned to the Lower Precambrian of Manchuria and to the Wutai system of North China.	

(Column not drawn to scale)

* Name not shown on the map.