GEOLOGIC COLUMN AND UNIT DESCRIPTIONS

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	REMARKS
CENOZOIC	Alluvium	Qal — *Mud, clay, sand, and gravel. Thickness between 20 m and 30 m*	Terrace deposits and loess are included.
		Unconformity	
MESOZOIC	Quartz porphyry	qp — *Quartz porphyry and other porphyries*	Quartz porphyry, feldspar porphyry, and granite porphyry occur in dikes.
	Diorite	dz — *Diorite and porphyrite*	Diorite and porphyrite in dikes; dark green; with or without augite.
	Granite	g3 — *Hornblende-biotite granite*	Red hornblende-biotite granite constitutes Chien Shan (千山), and has been assigned most recently to the Cretaceous from its lithological characteristics although no sedimentary rocks younger than the Sinian system are found in contact with it. The leucocratic part of this granite consists only of quartz and microcline perthite which is characterized by antiperthitic structure; such structure has hitherto been known only in the Cretaceous granite of the Je-ho district. Special constituents such as hastingsite, allanite, and fluorite also occur. Near Hai-cheng(海城) gray and medium-grained biotite granite is intruded into the Sinian quartzite, and is tentatively assigned to the Cretaceous.
	Volcanic complex	Mk — *Porphyrite, tuff, and agglomerate*	Effusive and intrusive sheets of porphyrite, associated with tuff, agglomerate, conglomerate, sandstone, and shale; probably correlated to the Shiragi series (Mk_2) of Korea.
		Unconformity?	
PALEOZOIC	Upper Paleozoic(?) formation	Pu — *Conglomerate and arkose sandstone; thickness more than 200m*	Red conglomerate and arkose sandstone constitute the hills scattered in the vicinity of Hsiung-yueh-cheng(熊岳城) hot spring; biotite andesite is intruded into the formation. Gravels of the conglomerate are granite, granite gneiss, schist, and quartzite. Hata (1925) made a tentative correlation of this formation to the Sinian quartzite, but later Imamura (1939) assigned it to the post-Sinian and Saito (1940) to the Paleozoic. No fossils to verify their correlations have been found.
		Unconformity?	
PRECAMBRIAN	Sinian system	pCu — *Chiaotou quartzite; thickness from 100m to 300m or more*	Chiaotou(樵頭) quartzite includes siliceous slate, commonly cross-bedded, with ripple marks and sun cracks.
		Nanfen shale, including marl; thickness from 100 m to 300 m	Nanfen(南芬)shale is characteristically reddish purple or yellowish to bluish green, and includes marly shale and marl.
		Tiaoyutai quartzite; thickness from 100 m to 500 m	Tiaoyutai(釣魚台)quartzite is white to light brown; ripple marks are common; near the base sandstone and conglomerate occur occasionally. In the western part of this sheet area, pCu is predominated by quartzite, with shale, sandstone, and conglomerate; thickness varies from 100 m to 700 m.
		Unconformity?	
	Diorite	di — *Diorite and amphibolite*	Diorite (epidiorite), partially amphibolite, with or without schistosity, occurs as sheets intruded mostly into the pre-Tashihchiao(大石橋) series (lower pCm). The principal outcrop near Hai-cheng reveals bands of dark-colored hornblende and light-colored saussuritized plagioclase, suggesting the rock may have been derived from a gabbroic rock. Diorite (epidiorite) near San-tao-kou about 16 km northeast of Hai-cheng (outcrops too small to be mapped) is intruded by a Precambrian pegmatite which contains rare element minerals.
		Intrusive contact	
	Gneiss complex	ggn — *Granite gneiss and migmatite gneiss*	Granite gneiss and migmatite gneiss; bands and xenoliths of crystalline schist, limestone, and paragneisses such as garnet-mica gneiss and sillimanite-garnet-mica gneiss are common. The Precambrian granite gneiss in Manchuria is supposed to be composed of two granites, Tuimienshan (對面山) granite and Kungchangling (弓長岭) granite, although they are not separately mapped here.
		Intrusive contact	
	Liaoho system	pCmu — *Kaiping series; phyllite and lenses of dolomite; thickness more than 1,000 m*	Kaiping(蓋平) series, which is best developed near Kai-ping, is composed of chlorite phyllite, chlorite-sericite phyllite, and lenses of dolomite; mica schist and staurolite-mica schist also occur occasionally.
		Toshihchiao series; predominantly dolomite with magnesite; approximate thickness 2,000 m	Tashihchiao (大石橋)series is composed chiefly of dolomite, commonly associated with magnesite. Alternating beds of chlorite phyllite, chlorite-sericite phyllite, talc phyllite, and dolomite occur locally, with occasional amphibole schist. Magnesite and talc deposits are most typical in the Ta-shih-chiao district. Magnesite-rich dolomite is one of the characteristics of the Liaoho (遼河) system. Tashihchiao series is generally separated from the Kaiping series and pre-Tashihchiao series by normal or thrust faults. The exact stratigraphic relationship of the three series would be difficult to determine were it not for the contrasts in their intensities of metamorphism, as observed in the Kai-ping district.
		pCml — *Pre-Toshihchiao series; mostly schist and gneiss; thickness 2,000 m or more*	Pre-Tashihchiao series is composed of sericite schist, biotite schist, staurolite-biotite schist, garnet-biotite schist, sillimanite-biotite schist, graphite schist, crystalline limestone, and quartzite; with occasional occurrence of iron formation and magnetite-bearing amphibole. These rocks often grade into gneisses which include injection gneiss, migmatitic gneiss, and granulite, some of which are constituents of the gneiss complex (ggn) described above.
AGE UNKOWN	Granite	g — *Undifferentiated granites*	The widespread undifferentiated granites have heretofore been regarded as Precambrian in age because they grade into the Precambrian gneiss complex (ggn). However, some of these granites have been found to cut the gneiss complex, implying that these granites are younger. The porphyritic granites near Ching-cheng-tzu(青城子), Hsiu-yen(岫岩), and Wan-fu-chuang(万福庄) are examples of this case. Several varieties of granite occur, such as biotite granite, two-mica granite, and hornblende-biotite granite, all having various textures. The granites in the map area, then, may include at least two Precambrian granites, the older Tuimienshan granite and the younger Kungchangling granite reported in the An-shan(鞍山) district, and some granites which are definitely younger. The euxenite-bearing pegmatites near Hai-cheng are believed to be closely related to the younger Precambrian or Kungchangling granite on the basis of age calculations of radioactive minerals contained.

(Column not drawn to scale)

REFERENCES

AOJI, Otoji, 1927, Explanation text to the geological map of Manchuria, Feng-huang-cheng(鳳凰城)sheet, 1:400,000: Geological Institute of South Manchuria Railway Co.

ASANO, Gorō, 1940, On the wolframite deposit and the geology of the region, especially on the metamorphic rocks of the so-called Liaoho(遼河)system, at Huang-chia-pu-tzu(黃家堡子)district, Hsiu-yen Prefecture, Antung(安東)Province: Memoirs of Geological Institute of Manchoukuo, no. 11.

_____ and IMAMURA, Zengo, 1940, Occurrence of Ta-Nb-bearing minerals and the geology of the region at Pai-lou-tun(牌樓屯)district, Hai-cheng Prefecture: Mem. Geol. Inst. Manchoukuo, no. 13.

HATA, Jūkichi, 1925, Explanation text to the geologic map of Manchuria, Ying-kou(營口)sheet, 1:400,000: Geol. Inst. South Manchuria Railway Co.

IMAMURA, Zengo, 1939, Hsiung-yueh-cheng hot spring, Kai-ping Prefecture, Fengtien(奉天)Province: Bull. Geol. Inst. Manchoukuo, no. 95.

_____, 1941, Geologic map of Manchoukuo, Ta-shih-chiao sheet, 1:150,000: Geol. Inst. Manchoukuo.

MATSUSHITA, Susumu, 1930, On the geology along the southern half of the Antung - Mukden line of the South Manchuria Railway: Ryojun College of Engineering Publication, no. 5.

OKADA, Shigemitsu, 1939, On the ore deposits and distribution of igneous rocks near Ching-chang-tzu: Mem. Geol. Inst. Manchoukuo, no. 10.

SAITŌ, Rinji, 1940, Geologic map of Manchoukuo, 1:3,000,000: Geol. Inst. Manchoukuo.