GEOLOGIC COLUMN AND UNIT DESCRIPTION

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION
QUATERNARY	Alluvium	Qal — Secondary loess, sand and gravel; thickness less than 10 meters	Alluvium, consisting of secondary loess intercalated with sand and gravel, is distributed in the coastal and river plains, and is especially prominent on the northwestern coast.
	DISCONFORMITY		
	Diluvium	Qdl — Yellow sandy loess, sand and gravel; thickness less than 20 m	Diluvium in the vicinity of Huang-hsien[黃縣] is mainly yellow sandy loess with sand and gravel, and covers low undulating hills.
	UNCONFORMITY		
TERTIARY	Tertiary basalt	Flows of basalt	Flows of basalt form the Miao-tao Archipelago including such islands as Ch'an-shan Tao[長山島], Miao Tao[廟島], Hsiao-hei-shan Tao[小黑山島], and Ta-hei-shan Tao[大黑山島], etc. The basalt is also distributed in the mainland at four isolated areas east and south of P'eng-lai[蓬萊]. The basalt was probably erupted during the Tertiary period.
	EFFUSIVE CONTACT		
MESOZOIC	Quartz porphyry	qp	A large dike of quartz porphyry, trending northeast, is found in the granite gneiss area of the Chao-yüan gold mine district. This is probably a marginal facies of the Cretaceous granite (g_3) which is widely exposed in the east.
	Cretaceous granite	g_3 — Biotite granite and porphyritic granite	Cretaceous granite occurs as laccoliths, and is composed mainly of coarse-grained biotite granite and porphyritic granite intruding various older rocks. The granite is the ore bringer of the gold-quartz veins and fluorite deposits in eastern Shantung, as exemplified by the gold-quartz veins of the Chao-yüan district and the Ping-tu district and the fluorite deposits of the Peng-lai district. The granite generally looks very fresh, and abounds in pegmatite, lamprophyre and felsite dikes.
	INTRUSIVE CONTACT		
	Ch'ingshan andesite formation	Mkq — Andesitic agglomerate, tuff, andesite, trachyte and clay; thickness 1,200 m	The Ch'ingshan andesite formation is a great volcanic complex which was probably formed between the end of the Lower Cretaceous and the beginning of the Middle Cretaceous. It consists chiefly of andesitic agglomerate, tuff, andesite and trachyte, intercalated with red clay. Lava predominates in the lower part, which is intercalated with red clay or tuff; agglomerate and tuff become predominant in the upper part.
	DISCONFORMITY		
	Laiyang formation	Mkl — Upper: sandstone and shale; Middle: shale and slate; Lower: conglomerate and sandstone; Total thickness 700 m	The Laiyang formation comprises three major divisions: the upper part or sandstone and shale (400 m or more thick) containing no fossils; the middle part or insect and fish fossil bed (about 200 m thick) consisting chiefly of paper shale, intercalated with slaty layers, especially in the lower part; and the lower part (100 m thick) consisting essentially of conglomerate alternating with buff quartzitic sandstones, and entirely barren of fossils. The middle part yields the following fossils: Insecta: Laiyangia paradoxiformis GRABAU, Sinoblatta laiyangensis GRABAU, Proterocsarabaeus yeni GRABAU, Chironomoptera (Samaruna) gregaria PING, Ch. (S.) malanura PING, Coptoclava longipoda PING, Mesolygaeus laiyangensis PING, M. rotundocephalus PING; Pisces: Lycoptera sinensis WOOEW., L. ferox GRABAU; Phyllopoda: Estheria cf. middendorfi R. JONES; Plantae: Brachyphyllus obsesum HEER, B. magnum CHOW, B. multiramosum CHOW, Sphenolepis elegans, Pagiophyllum sp., Palaeocyparis cf. flexuosa SAP., Auracarites sp., Haiera cf. australis M'Coy, Zamites sp., Thinnfeldia sp. The Laiyang formation is Lower Cretaceous in age.
	UNCONFORMITY		
	Pre-Laiyang andesite	Mja — Flows of porphyroid trachyandesite, volcanic ash and breccia; thickness unknown	Andesite of pre-Laiyang age consists essentially of porphyroid trachyandesite flows, interbedded with clayey volcanic ash and breccia.
	EFFUSIVE CONTACT - UNCONFORMITY		
PALEOZOIC	Ordovician formation	Plo — Dolomitic limestone, dolomite and shale; thickness unknown	The Ordovician formation consists, in descending order, of dark massive dolomitic limestone, and argillaceous limestone or dolomite and shale in variable sequence. The thickness is unknown, but the corresponding "Chi'nan formation" (WILLIS & BLACKWELDER, 1912) in Chi-nan, capital of Shantung, was measured as 850 m. The age of the formation is thought to range from Lower to Middle Ordovician.
	PROBABLE DISCONFORMITY		
	Cambrian formation	Plc — Shale, sandstone, quartzite and limestone; thickness unknown	The Cambrian formation is composed of shale, sandstone, quartzite and limestone, although no details are available.
	RELATION UNKNOWN		
PRECAMBRIAN	Sinian system (?)	pCu — Phyllite and quartzite; thickness unknown	The "Sinian system" northeast and southeast of Huang-hsien is based on the 1:2,000,000 Nanking sheet (Tokyo Geog. Soc., 1929), although no reliable stratigraphic data are available. It is supposedly composed of phyllite and quartzite. It may be a sandstone facies of the Sinian system, and it may be equivalent to the Haiyang formation (refer to the Ch'ing-tao sheet NJ 51-13 adjacent on the south), or a granitized facies of the Triassic-Jurassic diabase and phyllitic slate. Further study is required for precise age determination.
	UNCONFORMITY		
	Precambrian schist, or Wutai system	pCsh — Biotite-muscovite schist, hornblende schist, limestone, graphite schist and talc-hornblende schist; thickness unknown	Schist, probably belonging to the Wutai system, consists chiefly of biotite-muscovite schist and hornblende schist intercalated with thick limestone layers, and occasionally contains graphite schist and talc-hornblende schist. They are generally associated with minor injections of gneissose granite.
	RELATION UNKNOWN		
	Precambrian gneiss, or Taishan complex	pCgn — Granite gneiss, mica gneiss, and undifferentiated gneisses; thickness unknown	Gneiss of the Taishan complex consists chiefly of granite gneiss and mica gneiss, with other gneisses of unknown origin and character. It is usually intruded by granite, pegmatite, and dioritic rocks, which are relatively young, although some may be Precambrian.

(Column not drawn to scale)

ECONOMIC VALUE

Gold

Gold ores of the map area may be genetically related to the Cretaceous granite. They are distributed in Chao-yüan Hsien[招遠縣] (Au 1-9) and Ping-tu Hsien[平度縣] (Au 10-12) (numbers refer to deposits on map). The gold mines in Chao-yüan Hsien are 1 Ling-lung[玲瓏], 2 Chiu-ch'üan[九曲], 3 Tsui-tzu-chiang[嘴子頭], 4 Hung-ch'ing[紅旗], 5 Chin-shan[金山], 6 Huang-shan-kuan[黃山館], 7 Chu-chia[朱家], 8 Wang-chia[王家], and 9 T'ai-tzu[台子].

Gold at Ling-lung was found in the period of the Ming Dynasty. The mining rights were established in 1883, since then a Sino-Japanese company worked the deposit intermittently from 1935 to the end of World War II. Other mines were supervised by the Chinese government after 1935. The auriferous district consists chiefly of granite gneiss of the Taishan complex which is traversed by abundant dikes of pegmatite, lamprophyre, and felsite. The Ling-lung and adjacent Chiu-ch'üan mines ranked in top production with large auriferous pyrite-quartz veins. There are three productive veins at Ling-lung, and five at Chiu-ch'üan. The main vein, or the so-called "Linglung lode", passes through these two mines, with an approximate length of 3 km and a width of 8 m. The auriferous quartz veins contain sporadic ore shoots which are delimited along both strike and dip. The visible ore reserves of even the Ling-lung mine, one of the most famous gold mines in China, has been worked out, hence, large scale prospecting would be required before systematic exploitation is begun. Ore generally occurs in pyrite-quartz veins rarely accompanied by chalcopyrite and galena.

The gold mine of Ping-tu Hsien includes 10 Suan-shan[蒜山], 11 Tiao-hua-chien[刁花澗], and 12 An-erh-chien areas, where the gold deposits were found by natives during the Ming Dynasty. The mining rights, together with the Ling-lung gold mine in Chao-yüan Hsien, were given to a certain Chinese in 1883. An American mining engineer (they say he was President Hoover in his youth) helped develop the project, but the mine was closed in 1886. In 1931 the mine was reopened but was closed again before long. The gold ore is similar in nature to that of the Ling-lung. The auriferous pyrite-quartz veins occur in metagneiss which consists mainly of mica schist intruded by granite gneiss. Dikes of pegmatite and lamprophyre abound.

Fluorite

Fluorite-quartz veins are found in the Cretaceous granite area south of P'eng-lai. Important localities are 1 Hsien-chia-kou[咸家溝], 2 Chi-chia-kou[紀家溝], 3 Chü-chia-kou[巨家溝], and 4 Te-kou-tien[德口店]. Before and during World War II these mines were operated by native methods to supply raw material for the iron refining industry in South Manchuria. Production from each of these mines was less than 25 tons per day.

Mica

Mica is known at Ch'üan-sui-yen[泉水堰]5 km north of the Ping-tu gold mine. A micaceous pegmatite dike in the granite gneiss yields workable mica, but sheets larger than 5 inches in diameter are seldom found.

Hot springs

1 Ai-shan[艾山]hot spring is 12 km north of Chi-hsia-hsien [棲霞縣]. The temperature of the spring water is not very high.

2 T'ang-chi[湯集], or Wen-shih[溫石], hot spring is 26 km south of P'eng-lai.

3 T'ang-shang, or Tsu-lai-t'ang[白米湯], is 3.5 km east of Chao-yuang-hsien.

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