

GEOLOGIC COLUMN AND UNIT DESCRIPTION

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION	ECONOMIC VALUE	REFERENCES	
QUATERNARY	Alluvium	Secondary loess, sand and gravel; thickness less than 10 meters	Alluvium consists chiefly of secondary loess intercalated with sand and gravel. It covers bay deltas and river plains, and also forms talus on low hills. The thickness is generally less than 10 m but piedmont fans are locally as thick as 20 m.		CHARDIN, F. T. de, and YANG, Kieh, 1937, Structural geology of eastern Shantung (between Tsingtao and Yungch'eng): China, Geol. Survey Bull., no. 29.	
	Diluvium	Sandy loess, silt and clay; thickness less than 10 m	Diluvium in the Chi-mo basin consists in descending order of hard sandy loess (1.5 m), black silt (0.8 m), and brown sandy clay (thickness unknown) containing iron pisolites and calcareous concretions. The total thickness is probably less than 10 m.		IWAO, Chūichi, 1951, Nonmetallic ore deposits of Ch'ing-tao, in Geology and mineral resources of the Far East, North China, III-3p-1: Comp. Comm. Geology and Mineral Res. Far East, Tokyo Geog. Soc.	
MESOZOIC	UNCONFORMITY					
	Quartz porphyry	Quartz porphyry and rhyolitic lavas	Quartz porphyry comprises dikes and sheets of quartz porphyry and rhyolitic lavas showing a flow structure. It is probably a marginal facies of the Cretaceous granite (g ₃).	Barite Barite at Nan-ch'ian (南泉) was once worked by a Japanese. It occurs in quartz veins 4 miles east of Nanchuan station of the Tsingtao-Tsinan Railway. The mining area consists of an assemblage of reddish shale and sandstone, tuff, tuff-breccia, conglomerate, and andesite lava flows, which show a very gentle undulation. The ore veins may have some connection to the post-volcanic action of the quartz porphyry (qp). The ore reserves were thought to be fairly large.	MONDEN, Shigeyuki, 1940, Geology of Ch'ing-tao: Shantung Nat. History Mus.	
	INTRUSIVE AND EFFUSIVE CONTACT					1940, The fluorite deposits of Shantung and Kiangsu: Shantung Nat. History Mus., Bull., no. 4.
	Cretaceous granite	Biotite granite, felsitic granite, syenite, lamprophyre, quartz porphyry, felsophyre and quartz porphyry	Cretaceous granite occurring as intrusive laccoliths consists chiefly of pinkish biotite granite and light gray felsitic granite, accompanied by intrusive bodies of syenite, lamprophyre, granite porphyry, felsophyre and quartz porphyry.	Fluorite (1) The P'eng-chia-chuang (彭家莊) fluorite deposit, 20 km northeast of Ch'ing-tao, was worked by a Japanese in 1926 by small open pits. The ore deposit consists of calcite-fluorite veins cutting diorite, and is probably an earlier product of differentiation of the Cretaceous granite (g ₃). The ore reserves are not very large. (2) The Chiang-chia-chuang (姜家莊) fluorite deposit lies about 4 km south-east of the above-mentioned locality. The ore veins in the hills consisting of quartz porphyry were worked by the same Japanese. The ore reserves are not promising. (3) Minor exposures of fluorite veins were reported from Kou-ta-fu (扣塔埠), 25 km north of Ch'ing-tao. Veinlets of ore scattered in the granite constituting hills 40 to 50 m high south of the gate of the village were worked on a small scale during World War II.	OZAKI, Hiroshi, and others, 1937, Reports of mines in North China, by Field Party II: Tech. Consultant Gp-B, Hq. Japanese Station Troops in Ch'ing-tao.	
	Wangshih formation	Clay, conglomerate and sandstone; thickness 2,000 m	The Wangshih formation, named after Wang-shih village in Chiao Hsien (膠縣) is 2,000 m thick. The upper two-thirds of the formation consists of red clay accompanied by red and white to gray conglomerate and sandstone, and dark clay containing reptilian bones. The lower one-third consists of red clay, and red and gray coarse sandstone and conglomerate.		T'AN, H. C., 1923, New research on the Mesozoic and early Tertiary geology in Shantung: China, Geol. Survey Bull., no. 5, pt. 2.	
	Cretaceous andesite or Ch'ingshan formation	Andesitic agglomerate, tuff, andesite, trachyte and clay; thickness 1,200 m	The Ch'ingshan formation, named after Ch'ing Shan northeast of Lai-yang, is 1,200 m thick. It constitutes a great volcanic complex that probably erupted between Lower and Middle Cretaceous time. The formation consists chiefly of andesitic agglomerate and tuff in the upper part, and andesite and trachyte intercalated with red clay in the lower part.		Tokyo Geographic Society, 1929, Geological atlas of Eastern Asia, Nanking sheet, scale 1:2,000,000.	
MESOZOIC	Laiyang formation	Upper: sandstone and shale	The Laiyang formation, named after Lai-yang city, is 700 m thick. Lithologically the formation is divided into three parts, the upper or sandstone and shale, the middle or insect and fish fossil bed, and the lower or basal conglomerate.			
		Middle: shale and slate	The upper part consists mainly of yellowish shale becoming more arenaceous and hard upward. It contains no fossils. The thickness is 400 m or more.			
		Lower: conglomerate and sandstone	The middle part consists of brownish gray to dark gray paper shale intercalated with hard gray slaty layers that increase toward the lower part. The shale yields insect fossils in various places as in the vicinity of Tuan-wang (團王) and Nan-wu (南武), etc. The slaty layers abound in fish fossils, mostly Lycoptera, accompanied by fossils of insects and plants. The following species were reported: Insecta: <i>Laiyangia paradoxiformis</i> GRABAU, <i>Sinoblatta laiyangensis</i> GRABAU, <i>Proteroscababaeus yeni</i> GRABAU, <i>Chironomaptera</i> (<i>Samaruna</i>) <i>gregaria</i> PING, Ch. (S.) <i>malanura</i> PING, <i>Coptoclaiva longipoda</i> PING, <i>Mesolycaeus laiyangensis</i> PING, <i>M. rotundicephalus</i> PING; Pisces: <i>Lycoptera sinensis</i> WOODW., <i>L. ferox</i> GRABAU; Phyllopora: <i>Etheria</i> cf. <i>middendorfi</i> R. JONES; Plantae: <i>Brachyphyllus obsesum</i> HEER, <i>B. magnum</i> CHOW, <i>B. multiramisum</i> CHOW, <i>Sphenolepis elegans</i> , <i>Pagiophyllum</i> sp., <i>Palaeocypris</i> cf. <i>flexuosa</i> SAP., <i>Auracrites</i> sp., <i>Baiera</i> cf. <i>australis</i> M'COY, <i>Zamites</i> sp., <i>Thinnfeldia</i> sp.			
		Total thickness 700 m	The lower part is composed essentially of conglomerate alternating with buff quartzitic sandstones, the total thickness being about 100 m. It is entirely barren of fossils.			
MESOZOIC	Haiyang formation	Porphyroid trachyandesite with volcanic ash and breccia; thickness unknown	The Haiyang formation, probably Jurassic or older in age, is divided into the pre-Laiyang andesite (M _{ja}) and the Haiyang slate (M _j).			
		Slate, quartzite and andesite; thickness several hundred m	The pre-Laiyang andesite occurring east of Chi-mo (即墨) constitutes a marked eruption complex. It is composed essentially of a dark violet porphyroid trachyandesite, interbedded with clayey volcanic ash and breccia. More siliceous layers with pyromerides are locally found within the mass, and form an important topographic ridge in the eastern limit of the eruptive zone. The complex seems to plunge conformably below the Laiyang sandstones near Chi-mo, although the precise contact is hidden under the alluvium.			
MESOZOIC	Haiyang slate		The Haiyang slate, named after Hai-yang city, is a prominent granitized complex consisting of slate, quartzitic rock and andesite, intruded by many parallel sheets of porphyroid granite. The complex is probably older than the Laiyang formation.			
		UNCONFORMITY				
PRECAMBRIAN	Precambrian schist or Wutai system	Biotite-muscovite schist, hornblende schist, crystalline limestone, dolomite, graphite schist, and talc-hornblende schist; thickness unknown	Precambrian schist consists chiefly of biotite-muscovite schist, hornblende schist, crystalline limestone and dolomite, with some graphite schist and talc-hornblende schist. In places the schist is intruded by granite gneiss. From lithographic features it can be correlated with the so-called Wutai system of North China.			
		RELATION UNKNOWN				
PRECAMBRIAN	Precambrian gneiss or Taishan complex		The gneiss of the so-called Taishan complex consists chiefly of granite gneiss and mica gneiss, with other gneisses of unknown origin and character. The complex is usually intruded by granite, pegmatite and dioritic rocks, which are relatively young but probably Precambrian in part. Various schists are also contained in the complex.			
		(Column not drawn to scale)				
				Mica (1) The Wang-ko-chuang (王哥莊) mica deposit lies 35 km northwest of Ch'ing-tao. The area is composed of the Taishan complex and consists chiefly of granitic gneiss and mica schist, with amphibole schist and amphibole gneiss, and numerous veins of quartz porphyry and lamprophyre. More than twenty exposures of mica-bearing pegmatitic quartz veins are distributed within an area of 1 km by 1 km; of these, two veins are workable, each being 50 to 70 m long and 3 to 7 m wide, dipping vertically. Amphibole schist and mica schist are the country rocks. Chemical analysis of the mica reveals the following (Geol. Survey of Japan, 1942): SiO ₂ , 48.40; Al ₂ O ₃ , 27.62; Fe ₂ O ₃ , 1.22; FeO, 2.68; MgO, 3.45; CaO, 0.28; K ₂ O, 15.23; Na ₂ O, 5.23; Ig. loss, 5.60; Total, 99.80%; TiO ₂ , 0.39; Li ₂ O, 0.00; F, 0.35. The composition corresponds to 23.5% potash-muscovite and 72.0% phengite. The mica has few cracks, is moderately flexible and shows high refractoriness and strong insulation. The color is light greenish gray to light brownish green. During World War II a Japanese company worked it on small scale by the open-pit method, and crude ore was sent to the processing factory at Ch'ing-tao. The diameter of the commercial products was 10 cm, 1-2%; 5 cm, 5-10%; smaller than 3 cm, 20-30%; and dust mica, over 50%. Mining the residual ore reserves may be promising. Mica-bearing quartz veins are known in the Taishan complex at Hung-shih-yai (紅石崖) 14 km west of Ch'ing-tao, but no prospecting was done.		
				Asbestos A deposit of asbestos is known in the vicinity of the Wang-ko-chuang, although it is inferior in quality.		
				Hot spring A hot spring is known at T'ang-shang (湯上), 19 km east-northeast of Chi-mo.		