GEOLOGIC COLUMN AND UNIT DESCRIPTIONS

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION	ECONOMIC VALUE
QUATERNARY	Alluvium	Qal — *Silt, clay, sand, gravel. Thickness less than 10 meters.*	Covers low terrace remnants, flood plains, and playas.	
	Diluvium	Qds — *Dune sand and silt. Thickness less than 20 m.*	Dune sand and silt (Qds) deposited in lacustrine areas during late Pleistocene, subsequently exposed and wind-eroded.	
		Qdl — *Loess, sandy loess, sand, and clay. Thickness less than 40 m.*	Interstratified sandy loess and clay of presumably lacustrine origin (Qdl) predominate in the map area. There also occur interstratified aeolian sand and loess. Red clay that generally underlies aeolian loess may be a Lower Pleistocene residual clay.	
		Unconformity		
TERTIARY	Neogene basalt	N — *Olivine basalt, tuff, and sand.*	Mainly flows and sheets of olivine basalt, locally attaining a thickness of several hundred meters, accompanied by tuff and sand. The basalt may have flowed through fissures during Pliocene and covered the Neogene peneplains. Mesas and buttes abound in semi-desert areas. In the coal fields of Shih-ta-fen [十大分] and Tung-yuan-pao-shan [東元寶山], dikes and sheets of the basalt are found intruded into the Mesozoic coal-bearing formation.	
		Unconformity		
MESOZOIC	Rhyolite	Rh — *Rhyolite, trachyandesite, tuff, and lava breccia.*	Flows and sheets of rhyolite accompanied by some trachyandesite and their pyroclastics. Some Japanese geologists call this rhyolite "Cretaceous volcanics".	
		Effusive contact		
	Granite	γ_3 — *Granite and granite porphyry.*	Biotite granite and biotite-hornblende granite, accompanied by minor amounts of granite porphyry, quartz porphyry and diorite; may have been intruded during the Cretaceous or post-Jehol formation. These granites may have introduced the gold veins. A purple granite mass forming the northern hills of Chih-feng [赤峰] is called "Chihfeng granite" and is considered to be an intrusion of Upper Cretaceous age.	Gold veins, which were probably brought about by the Cretaceous granite, occur in the districts listed below (and numbered on the map): 1. Ho-chia-ti [賀家地], 45 km east-southeast of Chih-feng, where gold was worked since nearly a century ago but the operation was suspended in 1919. In 1905 an Anglo-Chinese company was established in order to prospect thirty-odd quartz veins. Several vertical shafts were sunk by the company but in vain. 2. Chuan-shan-tzu [串山子], 55 km east of Chih-feng, where gold was worked in about 1915 but the ore was exhausted before long. 3. Hung-hua-kou [紅花溝], 27 km southwest of Chih-feng, where gold was worked for a short period at the end of the 19th century. No reserves were found by later prospecting. 4. Sau-fen-ti-pei-kou [四分地北溝], 32 km west-southwest of Chih-feng, where gold veins were reported to occur but not promising. 5. Shui-chuan [水泉], 12 km east of Hsiao-ho-yen [小河沿], where a gold quartz vein was once worked by a Chinese about 50 years ago.
		Intrusive contact		
	Jehol formation	J — *Tuff, tuffaceous agglomerate, conglomerate, sandstone, shale, coal, and oil shale. Thickness about 1,000 m.*	The Mesozoic Jehol formation can be divided into three parts: upper, middle, and lower, according to UEDA and SASAKURA (1937). The upper part, about 150 m thick, consists mainly of tuffaceous rocks, frequently intercalated with acidic lava sheets, generally covered by rhyolite flows. Fossils are not present. The middle part, more than 600 m in thickness, consists of interstratified shale, sandstone, and coal, and forms the coal-bearing beds which are observed in various coal fields of the map area. Fossils contained are Estheria sp. and Lycoptera joholensis var. minor Grabau from the oil shale deposits in the vicinity of Ta-miao [大廟], and Pityophyllum sp. from the coal-bearing beds in the coal field of Shih-ta-fen. The lower part, about 300 m thick, consists of tuffaceous rocks of andesitic character, occasionally accompanied by andesite flows. The age of the Jehol formation is believed to vary from Uppermost Triassic to Lower Cretaceous; although the coal-bearing beds at the coal fields of Shih-ta-fen, Hsi-yuan-pao-shan [西元寶山], Tung-yuan-pao-shan, and Liu-tiao-tzu-kou [柳條子溝], and the oil shale deposits at Ta-miao are commonly considered Upper Jurassic.	The coal fields numbered on the map are described as follows: 1. Shih-ta-fen coal field, 30 km southeast of Chih-feng, was opened by Chinese about a century ago. Total output up to 1936 was approximately 360,000 tons. Two of the five seams were workable, having a thickness of 6-9 m and 1.5 m respectively. The coal is black lignite. Average analytical values are; H_2O 17.7%, volatile matter 36.8%, fixed carbon 39.5%, ash 5.6%, sulphur 1.3%, calorific value 5,370, sp. gr. 1.31. Possible reserves as of 1936 were more than 36,000,000 tons. 2. Hsi-yuan-pao-shan coal field, 25 km east of Chih-feng, was opened by Chinese in 1907. Since then two seams of black lignite, 4 m and 6 m thick respectively, were worked. Interval between the seams is 6 m to 18 m. Total output up to 1933 was 750,000 tons. Structure of the coal field is a gentle monocline with minor undulations, and the strata generally strike northwest and dip to southeast. Later test-drilling proved that the coal-bearing formation contains more than ten coal seams with a total thickness of 22.43 m. The coal seams extend for 6 km on strike and 1 km on dip. Total probable reserves as of 1940 were 13,000,000 tons. 3. Tung-yuan-pao-shan coal field, 36 km east-northeast of Chih-feng was opened about 140 years ago, and intermittently worked by local Chinese miners. Workable seams are two, with respective thicknesses 1.8 m and 1.4 m. Average analytical values are; H_2O 22.14%, ash 6.04%, volatile matter 32.86%, fixed carbon 36.47%, sulphur 1.78%, calorific value 4,924. Test-drilling was not conducted. Estimated probable reserves as of 1940 were 5,400,000 tons. 4. Liu-tiao-kou-tzu coal field, about 35 km southwest of Chih-feng, includes such coal mines as (a) Ching-tzu-kou [井子溝], (b) Wang-tzu-fen [王子墳], (c) Liu-tiao-tzu-kou and Wu-tai-tzu [五台子]. The coal was discovered a century ago and was worked intermittently. The coal is low grade bituminous coal but occasionally becomes anthracitic on account of the effect of igneous injection. Analytical value of the coal from Wang-tzu-fen is as follows; H_2O 7.69%, volatile matter 21.31%, fixed carbon 60.00%, ash 10.73%, sulphur 0.66%, calorific value 5,775, sp. gr. 1.517. No estimation of coal reserves is reported.
	Andesite	A — *Andesite with its pyroclastics.*	Consists of mainly pyroxene andesite and amphibole andesite, with their pyroclastics, and attains a thickness about 200 m. Structure varies between porphyritic and cryptocrystalline. The age is locally contemporaneous with the middle and the lower parts of Jehol formation.	
	Porphyrite	P — *Diorite porphyry and diabase porphyry.*	Intrusive sheets and flows of porphyrite, consisting mainly of diorite porphyry and diabase porphyry, with their pyroclastics. Thickness not known. Exposures east and south of Hsiao-ho-yen [小河沿] are reported as diabase porphyry, and the ones in the district of Wu-tan-cheng [烏丹城] as diorite porphyry. Eruption of this porphyrite may have been earlier than that of the andesite described above, and probably has some connection with the deeper seated Triassic granite which is not mapped here.	
		Unconformity		
PALEOZOIC	Linhsi series ?	Ss — *Sandstone, shale, limestone, slate, hornfels, and mica schist. Thickness more than 2,000 m.*	The Upper Paleozoic formation in the map area consists mainly of sandstone and shale, locally intercalated with thick lenses of limestone, and frequently shows contact metamorphism on account of granite or diorite intrusion. Thickness is probably more than 2,000 m, and the age may be either Upper Carboniferous or Lowermost Permian. This formation may be correlated to the Linhsi series named by P. T. de Chardin for the Upper Paleozoic formation in the district of Lin-hsi [林西] (See adjacent Lin-hsi sheet, NK 50-3).	
		Probable unconformity		
MIDDLE PRECAMBRIAN	Wutai system	Sch — *Actinolite schist, mica schist, porphyroid, and crystalline schist. Thickness not known.*	The Middle Precambrian metamorphic complex in the map area can be correlated with the Wutai system, and consists of actinolite schist, mica schist, porphyroid, locally with lenses of crystalline limestone. Thickness is not known. In 1905, a large mass of limestone having a maximum width of 1.5 km and a length of 1.3 km was reported around Hsiao-shao-kou [小燒鍋], in the vicinity of Shang-shao-kou [上燒鍋].	Limestone was calcined for local lime industry.
LOWER PRECAMBRIAN ?	Gneiss	gn — *Granite gneiss, metagneiss, and crystalline schist.*	The gneiss consists of granite gneiss, metagneiss, and some crystalline schists, and is considered to present a transitional feature between Wutai system and Taishan complex (which does not occur in the map area).	

(Column not drawn to scale -)

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