GEOLOGIC COLUMN AND UNIT DESCRIPTION

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION
QUATERNARY	Alluvium	Qal — Silt, clay, sand, and gravel; thickness less than 10 meters	Alluvium, consisting of silt, clay, sand, and gravel, accompanied by aeolian sand and silt, is distributed in river flats, playas and swamps. Some playas in the central part of the map area form salt lakes.
	UNCONFORMITY		
	Diluvium	Qds — Aeolian sand and silt, with red clay; thickness less than 50 m Qdl — Loess, redeposited loess, and gravel; thickness less than 20 m	Diluvium is divided into Qds and Qdl. Qds, consisting of dune sand, silt and red clay containing calcareous nodules, was deposited in the fluvio-lacustrine basins of the Mongolian plateau during the late Pleistocene. Having been uplifted and wind-eroded later, the deposit has formed vast deserts where sand is blown eastward creating many bowl-like depressions. Qdl, consisting of loess, redeposited loess, and gravel, is exposed only in the vicinity of Chang-chia-yao-tzu〔張家窯子〕. It may have been deposited during the Middle Pleistocene.
	UNCONFORMITY		
TERTIARY	Neogene basalt	b_2 — Augite-olivine basalt with tuff and sandstone	Neogene basalt, known as "Hanoorpa basalt", occurs as lava flows and intrusive sheets, locally accompanied by tuff and sandstone. The rock is augite-olivine basalt, ranging in texture from fine doleritic to coarse diabasic, and is dense to highly vesicular. It constitutes the vast Mongolian plateau which may have been formed sometime from the Oligocene to the Pliocene, probably in the Miocene. The thickness locally attains several hundred meters.
	EFFUSIVE CONTACT		
	Paleogene formation (Tumulu series)	P — Clay, shale, sandstone, lignite and conglomerate; thickness 500 m	The Paleogene formation, or the Tumulu series〔土木路〕, is divided into two parts. The upper part consists of red, light yellow, dark brown or greenish gray clay, which locally passes into shale intercalated with fine-grained sandstone; gray soft lignite-bearing shale occurs at the base. The lower part consists of fine to coarse conglomerate interbedded with fine-grained cross-bedded sandy layers. In the Ta-ching-kou coal mine, 2 km northwest of Han-no-pa〔洋蛾坝〕, refer to the Chang-chia-kou sheet, NK 50-10), ANDERSSON (1919) collected plant fossils such as Pinus sp., Comptonia anderssonii, Carpinus sp., Phyllites sp., which were identified by R. FLORIN as probable Middle Tertiary in age. (See BARBOUR, 1929.) C. C. SUN (1934) assigned the Tumulu series to the late Cretaceous or Early Tertiary.
	UNCONFORMITY		
MESOZOIC	Cretaceous formation (Nantienmen series)	MK — Conglomerate and sandstone; thickness 180 m	The Cretaceous formation, or the Nantienmen series〔南天門統〕, consists of fine to coarse conglomerate alternating with fine-grained cross-bedded sandstone. Pebbles of the conglomerate are chiefly Lower Cretaceous rhyolite and its pyroclastics, 2 to 5 cm in diameter, becoming larger, 10 to 30 cm, toward the base. The formation probably correlates with the Chengte series of Jehol which is Middle to Lower Cretaceous in age.
	UNCONFORMITY		
	Cretaceous rhyolite	rh — Rhyolite with trachyte, tuff, sandstone, shale, and breccia; thickness several hundred meters	Cretaceous rhyolite, exposed in the northeastern part of the map area, is associated with trachyte, tuff, sandstone, shale and breccia. The unconformable relation between the rhyolite and the Nantienmen series is observed in the vicinity of Han-no-pa pass off the map sheet, to the south.
	EFFUSIVE CONTACT		
	Jurassic-Cretaceous formation	Mjk — Shale, sandstone, conglomerate, and coal; thickness more than 20 m	The Jurassic-Cretaceous formation consists of black shale, low-grade coal, coarse-grained cross-bedded sandstone, and conglomerate. The shale near Wan-chuan〔万全〕(refer to NK 50-10) yields plant fossils which were identified by A. C. SEWARD (see BARBOUR, 1929) as follows: Wealder-type of Lower Cretaceous: Onychiopsis psilotoides, Sphenopteris mantelli, Ruffordia goepperti Jurassic: Podozamites lanceolatus, Pityophyllum sp. Hence, the formation may range in age from Upper Jurassic to Lower Cretaceous.
	UNCONFORMITY		
	Upper Jurassic formation (Tachingshan series)	Mu — Sandstone, shale, and conglomerate; thickness 500 m	The Upper Jurassic formation, or the Tachingshan series〔大青山統〕, consists chiefly of sandstone intercalated with green red or locally dark gray shale and conglomerate. The conglomerate is composed of round pebbles of gneiss, marble, and white quartz cemented with sand. The age of the formation was assigned by C. C. SUN (1934) to the Middle to the Upper Jurassic, although no fossils have been found in it.
	DISCONFORMITY		
	Jurassic-Triassic formation (Shihkuai series)	Mk — Conglomeratic sandstone with shale and coal, and limestone; thickness 300 m	The Jurassic-Triassic formation, generally known as the "Shihkuai coal series"〔石拐煤統〕, consists of gray, greenish gray, and light gray conglomeratic sandstone with argillaceous shale and two to eight seams of coal. Thin lenses of limestone occur locally. In the district adjacent on the west of the map area the formation rests disconformably on the Permian-Triassic formation. The age of the formation of the map area was defined by RICHTHOFEN (1882) as Lower Jurassic on the basis of the plant fossils collected near Tu-mu-lu, such as Asplenium whitbyense Brongn, A. argutulum Heer, Anomozamites sp., Pterophyllum richthofeni Schenk, P. aequale Brongn, Podozamites gramineus Heer, P. lanceolatus Heer and Elatides chinensis Schenk. The formation may be correlated with the coal-bearing formation of the Ta-tung〔大同〕 and Men-tou-kou〔門頭溝〕coal fields.
	UNCONFORMITY		
	Pre-Jurassic(?) granite	g_2 — Hornblende-biotite granite	Pre-Jurassic(?) granite in the northwestern part of the map area is reddish gray medium-grained granular hornblende-biotite granite for which few data are available.
	INTRUSIVE CONTACT		
PALEOZOIC	Upper Paleozoic formation (Linhsi series?)	Pu — Sandstone, shale, limestone, clay slate, hornfels, phyllite, and mica schist; thickness more than 1,000 m	The Upper Paleozoic formation consists of sandstone, shale, and limestone, and is locally accompanied by clay slate, hornfels, phyllite and mica schist. The formation near Ku-yüan〔沽源〕is intensely folded. The thick lenses of limestone yield numerous fossil crinoids, corals, and foraminifers. The age of the formation is either Upper Carboniferous or Lowermost Permian. The formation may be correlated with the Linhsi series〔林西統〕named by P. T. de CHARDIN (refer to the Lin-hsi sheet, NK 50-3).
	UNCONFORMITY		
PRECAMBRIAN	Upper Precambrian formation (Sinian system)	pCu — Limestone, shale, slate, hematite ore bed, quartzite, sandstone, and conglomerate; thickness more than 1,000 m	The Upper Precambrian formation, or the Sinian system, exposed near Tu-shih-k'ou〔獨石口〕strikes E-W and can be divided into two parts. The upper part consists in descending order of limestone, siliceous limestone, an alternation of siliceous phyllite and calcareous slate, with a hematite ore bed at the base. The lower part consists of thickbedded quartzite, argillaceous sandstone, and local conglomerate, in descending order.
	UNCONFORMITY		
	Crystalline schist (Wutai system)	Sch — Hornblende schist, biotite schist, chlorite schist, garnetiferous leptynite, mylonitic gneiss, limestone, and quartzite	Crystalline schist, or the Wutai system, is exposed in the central part of the map area and strikes E-W. It consists chiefly of hornblende schist, biotite schist, and chlorite schist, in association with highly garnetiferous leptynite and mylonitic gneiss. It is also characterized by local occurrences of limestone and quartzite.
	UNCONFORMITY		
	Gneiss complex (Sangkan gneiss)	gn — Injection gneiss, granite gneiss, garnetiferous leptynite, femic gneiss, and amphibolite	The gneiss complex, or the Sangkan gneiss, is sporadically exposed throughout the map area. It consists chiefly of injection gneiss in association with granite gneiss, garnetiferous leptynite, femic gneiss, and amphibolite. The injection gneiss varies in composition from arkosic quartz to garnetiferous schist, including hornblende schist, biotite schist, and chlorite schist. The schistosity generally trends to northeast.

(Column not drawn to scale)

ECONOMIC VALUE

Coal

Coal of the Paleogene formation (P1) occurs always in the uppermost horizon, immediately below the Hanoorpa basalt (b_2).

⊗1: Ta-ying-pan〔大營盤〕coal field, 12 km southwest of Chang-pei. One low-grade lignite seam, ranging from 20 cm to 1.5 m in thickness, was formerly worked by a small pit. The result of analysis shows 21.48% moisture, 36.18% volatile matter, 17.94% fixed carbon, 24.40% ash, and calorific value 4,166.

⊗2: Tung-yao-kou〔東窯溝〕coal field, 4 km east of Tu-mu-lu. One seam of brown lignite ranging in thickness from 30 cm to 1.5 m was formerly worked, but no production was reported. The seam extends eastward from Tung-yao-kou to Tao-li-pa (out of map area). According to C. C. SUN (1934) the coal reserves are about 1,440,000 tons.

Coal in the Jurassic-Cretaceous formation (Mjk) occurs in yellow or white shale.

⊗3: T'an-yao-kou〔炭窯溝〕coal field. Seams of brown lignite were once worked, but now several abandoned pits remain.

The Jurassic-Triassic formation (Mk) is the best coal-bearing formation in the map area. The coal is superior in quality, and ranges in rank from anthracite to bituminous.

⊗4: Tu-mu-lu coal field, 6 km west-northwest of Tu-mu-lu, extends southwestward from Ta-pa-kou for about 8 km to Sou-tzu-ping. Of eight coal seams, two (1.2 m and 2.4 m thick respectively) are worked by the Hengsheng Coal Mining Company. The coal is bituminous and coking. The result of analysis is as follows: 0.82% moisture, 27.26% volatile matter, 62.79% fixed carbon, 9.15% ash, calorific value 7,817. According to C. C. SUN (1934) the average thickness of coal seams is 2 m and the reserves are 4,800,000 tons.

⊗5: Ma-lien-ko-ta coal field, 16 km west of Tu-mu-lu. Two coal seams, 1.5 m and 21 m thick, are worked by the Chengping Coal Mining Company. The coal is anthracite, and chemical analysis shows 0.98% moisture, 8.78% volatile matter, 74.64% fixed carbon, 15.60% ash, and calorific value 7,261; it is non-coking. Coal reserves are about 3,900,000 tons according to C. C. SUN (1934).

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