GEOLOGIC COLUMN AND UNIT DESCRIPTIONS

AGE	ROCK UNIT		LITHOLOGY; THICKNESS WHERE KNOWN
QUATERNARY	Alluvium	Qal	Sand, clay and gravel; thickness less than 10 meters
	Diluvium	Qdss	Qdss: aeolian dune sand; thickness more than 30 m
		Qds	Qds: sand, clay and gravel; thickness more than 50 m
	UNCONFORMITY		
TERTIARY	Neogene basalt	N	Olivine-augite basalt
	EFFUSIVE CONTACT		
MESOZOIC	Cretaceous andesite	Mka	Biotite andesite and dacite
	EFFUSIVE CONTACT		
	Cretaceous rhyolite	rh	Rhyolite and cryptocrystalline rhyolite
	EFFUSIVE CONTACT		
	Lower Cretaceous formation	Mk	Conglomerate, sandstone, shale, tuff and coal; thickness unknown
	UNCONFORMITY		
	Diorite	δ	
	Cretaceous granite	γ_3^3	Biotite granite
	INTRUSIVE CONTACT		
	Jurassic formation	Mj	Sandstone, quartzite, conglomerate, shale and tuff; thickness unknown
	UNCONFORMITY		
	Jurassic(?) andesite	Mja	Cryptocrystalline andesite
	Jurassic volcanic complex (Greenstone complex)	Mjv	Diorite porphyry, andesite porphyry, diabase porphyry, dolerite, propylite, breccia, tuff and sandstone; thickness more than 500 m
	EFFUSIVE CONTACT		
	Quartz porphyry	qp	
	Pre-Jurassic granite	γ_3^2	Biotite granite, hornblende granite, gneissose granite, diorite and aplite
	INTRUSIVE CONTACT		
PALEOZOIC	Lower(?) Paleozoic formation	Pl	Shale, clay slate, phyllite, schist, gneiss and hornfels; thickness unknown
	Granite gneiss	γgn	Granite gneiss and injection gneiss

Column not drawn to scale

UNIT DESCRIPTION

Alluvium, consisting of sand, clay and gravel, is distributed in the drainage basins of the Hai-la-erh Ho(海拉爾河), the Argun River and their tributaries, covering flood plains and low terrace remnants. Regions of alluvial deposits are characterized by numerous playas and swamps. Some of the inland lakes have no outlets, resulting in saline bottom deposits. Recent sand dunes are found in places.

Diluvium can be divided into Qdss and Qds.

Qdss consists chiefly of aeolian dune sand of Pleistocene to Recent age, and is sporadically distributed in the southern part of the map area. The dune sand is yellowish brown, yellowish gray, or light brown fine-grained quartz sand, and is 30 m thick on a hill east of Hailar.

Qds, consisting of sand, clay and gravel, is a Pleistocene deposit of aeolian, fluviatile and lacustrine origin, known as the Hulunbaierh formation (呼倫貝爾層). Eight drillholes in the vicinity of Hailar revealed the following sequence in descending order (depth in meters, drillhole numbers refer to sites numbered on map):

Hailar No. 1 (Japanese house in Erh-tao street)		Hailar No. 2 (Japanese Army Quarters, I)		Hailar No. 3 (Japanese Army Quarters, II)		Hailar No. 4 (Stud farm)	
0 - 1	Clay with sand	0 - 2	Yellowish white coarse sand	0 - 1	Clay with sand	0 - 3.5	Light yellow clay with sand
1 - 3	Gravel	2 - 3	Sand	1 - 2	Sand with gravel	3.5-21.5	Light yellow fine sand
3 - 9	Yellowish white sand	3 - 4	Gravel	2 -10	Gravel	21.5-28.5	Light yellow clay
9 - 17	Yellowish white fine sand	4 - 8.5	Yellowish white sand	10 -11	Gravel with clay	28.5-34.5	Light yellow sand
17 - 20	Gravel	8.5- 9.5	Gravel	11 -12	Sand		
20 - 29	Yellowish white clay	9.5-15.5	Yellowish white sand	12 -15	Sand with clay		
29 - 35	Yellowish white sand	15.5-18	Yellowish white coarse sand	15 -17	Yellow white sand		
		18 -19.5	Yellowish white clay	17 -24	Yellow white clay		
		19.5-20.5	Yellowish white sand	24 -25	Grayish blue clay		
		20.5-34	Yellowish white clay	25 -30	Light yellow sand with clay		
		34 -37.2	Yellow clay	30 -31	Grayish blue clay		
				31 -36	Gravel of small pebbles		
				36 -37	Sand with clay		
				37 -39.5	Gravel of small pebbles		
				39.5-	Light yellow clay		

Hailar No. 5 (Hospital)		Ta-liang-shang(大良上), Drillhole 6 15 km north of Hailar		Yao-lu-tzu(腰炉子), Drillhole 7 2.5 km east of Hailar		Chih-chien-fang(七間房), Drillhole 8 2 km northeast of Hailar	
0 - 5	Light yellow sand with gravel	0 - 1	Brown sand	0 - 1.1	Soil	0 - 0.7	Soil
5 -14	Light yellow coarse sand	1 - 5	Light brown clay	1.1-32	Aeolian sand and yellowish gray fine sand	0.7-15	Grayish white aeolian sand
14 -16	Sand with gravel	5 - 9	Grayish white fine sand	32 -34	Sandy clay	15 -22.5	Sand and gravel
16 -17	Light yellow clay	9 -13	Light brown clay with sand	34 -40.5	Blue clay with gravel		
17 -18	Sand with clay	13 -15	Light brown fine sand	40.5-41	Bluish black sand		
18 -22	Red clay	15 -19	Brown gravel	41 -46.8	Gravel and sand		
22 -23	Sand with clay	19 -20	Coarse sand				
23 -24.5	Red clay	20 -22	Light brown fine sand				
24.5-26.5	Light yellow fine sand	22 -31	Coarse sand				
26.5-30.5	Light yellow sand with clay	31 -32	Gravel				
		32 -37	Light brown sand				
30.5-36.5	Light yellow fine sand	37 -38.2	Light brown coarse sand				
36.5-38.5	Light yellow clay						
38.5-40.5	Light yellow sand						
40.5-42.5	Gravel						
42.5-43.5	Light yellow clay						
43.5-44.5	Gravel						
44.5-45.5	Clay						
45.5-46.5	Fine sand						
46.5-47.5	Clay						
47.5-48.5	Fine sand						
48.8-50.8	Light yellow clay						
50.8-54.8	Light yellow fine sand						
54.8-56.8	Light yellow clay						
56.8-59.8	Light yellow sand						
59.8-61.3	Light yellow clay						

Underlying the Hulunbaierh formation is a fluvial-lacustrine deposit containing animal fossils of the Pleistocene age, which is called the Hailar formation (Qdg on other map sheets). According to the record of two drillholes sunk in the vicinity of Hailar in 1935, the deposit at the Hailar Bridge, 5 km north of Hailar is covered by Recent clayey sand 4 to 6 m thick, and consists chiefly of sandy clay which yields Elephas primigenius (Blum) var. and Bos primigenius Bojanus. The deposit at An-pan-ch'eng, 5 km west of Hailar, has the following sequence in descending order (with depths from the ground surface): Light yellowish brown clayey fine sand (0-5 m) containing Cyraulus gredleri var. ströмi (Westerlund) and Pisidium (Pupisidium) cinereum Alder, alternating sand and gravel 30 to 50 cm thick each, (5-10 m), containing mammalian fossils at the horizon 6.5 m deep, yellowish brown fine sand (10-20.2 m) containing mammalian fossils, such as a foot bone of Bos primigenius and many fragments of limb bones of quadrupeds, at the 18 m horizon. The Hailar formation is correlated with the Ruhsiangt'un formation of SHIKAMA and with the Ch'alainerh formation(札賚諾爾層) on the basis of fossils.

The Neogene basalt is dark gray or black massive cryptocrystalline trap type basalt, rarely containing olivine and augite phenocrysts.

Cretaceous andesite includes two lithologic types, biotite andesite and dacite. Biotite andesite is light to dark green, massive, compact and vesicular, showing a flow structure. The rock resting on the Cretaceous rhyolite (rh) near Pa-t'u-lu Shan(巴圖魯山) is grayish green and shows a rhyolitic structure, and that near T'ou-chan(頭站) is dark brown and contains visible phenocrysts of biotite and feldspar. The rock overlain by the rhyolite near K'u-k'u Ha(庫庫哈) in the south-central part of the map is a light gray, brown or dark brown, massive dacite, having phenocrysts of quartz, plagioclase and biotite. It is probably an acidic type of biotite andesite lava. The rock in the hill west of Ihi Ko near the west edge of the map is an agglomeratic dacite.

The Cretaceous rhyolite consists of assemblage of rhyolite proper and cryptocrystalline rhyolite. It is locally associated with obsidian in the vicinity of Chiang-hsing Shan(將星山) along the Mo-erh-ko Ho, and with trachyte in the vicinity of Obön Pass north of Kan-ching-tzu. The rock near Garösu shows a flow structure and rarely a spherulitic structure.

The Lower Cretaceous formation is exposed in the following four places:
(1) The formation on the north bank of the Hai-la-erh Ho, 15 km northeast of T'so-kang(磋崗) rests on the pre-Jurassic granite (γ_3^2). It consists chiefly of conglomerate, thinly intercalated with sandstone and shale. Pebbles of the conglomerate are quartz porphyry and Paleozoic rocks, 1 to 10 cm in diameter and are cemented by medium-grained sand. The shale is gray or blue, and the sandstone is light gray and medium- to fine-grained. The formation strikes N to N 20° W, and dips 50° W to 20° E. The western boundary is faulted against gneissose granite.
(2) The formation in the cliff 20 km south of Hailar is covered by the Pleistocene deposit. It consists of sandstone and conglomerate containing pebbles of quartz porphyry. It strikes N 20° - 40° E and dips 20° - 30° SE.
(3) The formation on the hill 15 km north of K'u-k'u Ha is interbedded in the rhyolite flow. It consists of sandstone, shale, conglomerate and tuff, having the same dip and strike as the schistosity of the rhyolite flow.
(4) The formation near a pass 23 km northwest of T'ou-chan consists essentially of sandstone. It is overlain by the Cretaceous andesite (Mka), and strikes N 20° E, dipping 50° E.

The formation on the northwestern bank of the Argun River, U.S.S.R., rests on the pre-Jurassic granite (γ_3^2) and the Jurassic volcanic complex (Mjv). It consists of sandstone, shale, conglomerate and coal, and is defined as a Lower Cretaceous formation (MALIVKIN, 1955). Few data are available on coal seams.

Diorite crops out in a cliff 5 km northwest of Hailar. It is probably a facies of the Cretaceous granite.

Cretaceous granite is exposed in the northeastern part of the map area. It is composed chiefly of biotite granite intruding the Lower Paleozoic formation.

The Jurassic formation is exposed on the hills north of Hailar. It strikes N 50° - 55° W and dips 6° - 15° SW. The stratigraphic sequence in descending order is as follows: (1) light yellow coarse-grained sandstone, (2) quartzite locally associated with conglomerate, (3) light gray sandstone intercalated with black shale which yields plant fossils such as Todites williamsoni (Brongn.)? and Pityophyllum cfr. lindströemi Nathorst, and (4) grayish green tuff. On the basis of the fossils, the formation is assigned to Upper Jurassic. The tuffaceous sandstone and shale exposed in the cliff 8 km northeast of Hailar may correspond to the Jurassic formation. The formation near Shöerutoi in the northeastern part of the map area consists of sandstone, siliceous slate, tuff and conglomerate containing pebbles of Paleozoic rocks. The formation is intruded by the Cretaceous granite and shows a folding structure.

Jurassic(?) andesite occurs as flows resting on the Jurassic volcanic complex (Mjv). It is exposed in the following three places: (1) The andesite in the hills such as Cheng-ta-ch'i Shan(鄭達乞山) along the Argun River is black, compact and cryptocrystalline, having no visible phenocrysts. Under a microscope, the groundmass containing hornblende phenocrysts shows an andesitic structure. (2) The rock at Obön Pass 7 km south of Garösu is a grayish purple cryptocrystalline rhyolitic andesite having lenticular vesicles filled with calcite. (3) Andesite of probable Jurassic age crops out in a small area 8 km north-northeast of Hailar.

The Jurassic volcanic complex, or greenstone complex, consists of an assemblage of dark greenish igneous intrusives and extrusives. It is exposed in the following three places: (1) The complex near Hotoguchi along the Argun River consists of diorite porphyry, andesite porphyry, diabase porphyry, dolerite, volcanic breccia, tuff and sandstone. (2) The complex in the vicinity of Hailar consists of reddish hornblende diorite porphyry. (3) The complex near Naruinkisutan in the U.S.S.R. is assigned to Upper Jurassic undifferentiated effusives (MALIVKIN, 1955). It rests on the pre-Jurassic granite (γ_3^2) and is overlain by the Lower Cretaceous coal-bearing formation (Mkl).

Quartz porphyry is exposed on the hills between the Argun River and the Hailar River. It is probably a marginal facies of the pre-Jurassic granite. The quartz porphyry in the northeastern corner of the map area is probably Cretaceous in age. Some agate occurs in a hill 8 km southeast of Haji-san.

The pre-Jurassic granite is exposed in the northwestern part of the map area. It intruded the Lower Paleozoic formation and contact-metamorphosed it. It consists chiefly of biotite granite associated with hornblende granite, gneissose granite, diorite, and aplite in the Manchurian side. The granite in the U.S.S.R. is defined by Soviet geologists as Paleozoic acidic intrusives, such as granite, granodiorite and quartz diorite.

The Lower(?) Paleozoic formation in Manchuria consists of a complicated assemblage of shale, clay slate, phyllite, schist, gneiss and hornfels. These rocks were probably metamorphosed from the Paleozoic sandstone and slate due to the granite intrusion. The formation does not contain calcareous rocks or fossils that help determine the geologic age. The formation in Manchuria is known in the following four places: (1) The formation in the cliff 8 km northeast of Ts'o-kang consists of dark green hornblende-biotite schist and gray mica schist. Its schistosity strikes N 45° - 85° E and dips 25° - 60° NE. It was probably derived from clay slate by the contact-metamorphism of granite. (2) The formation near Shöerutoi consists of black clay slate, phyllite and dark gray sandy slate. It strikes N 40° - 45° E and dips almost vertically to north or south, forming complicated folds. (3) The formation in the hill 3 km south of Haji-san consists chiefly of hornfels and injection gneiss derived from sedimentary rocks due to the intrusion of biotite granite. (4) The formation along the cliff 3 to 13 km northeast of Sa-la-t'ui Shan(薩拉圖山) consists of siliceous clay slate and biotite metagneiss. It strikes N 60° E and dips 30° - 40° SE. It is intruded by the pre-Jurassic granite and is overlain by the Jurassic volcanic complex. The siliceous clay slate is yellowish gray and compact, showing marked joints, and locally contains unmetamorphosed fresh shale. The gneiss interbedded in the slate occurs near the contact with granite. It consists of an alternation of biotite, light yellow feldspar, and thin layers of siliceous rocks showing a banded structure. It was metamorphosed from siliceous clay slate. The formation in the northwestern corner of the map area was assigned to Lower Cambrian by the Soviet geologists, but available data are few.

A granite gneiss in the cliff 8 km northeast of T'so-kang surrounds the Lower Paleozoic schist. An injection gneiss exposed near Haji-san in the boundary zone between hornfels and granite shows a banded structure. Both were probably metamorphosed from the Lower Paleozoic formation by granite intrusion.

ECONOMIC VALUE

Building stone
Neogene basalt in the cliff 6 km north of Hailar can be used as building stone.

Building stone
Shale interbedded in the Jurassic formation exposed in the hill 2 km north of Hailar was formerly quarried, but the rock is too fragile to be used as building stone.

Fluorite
Quartz veins in the quartz porphyry and the Jurassic andesite near Haji-san contains fluorite which is of little economic value due to small reserves and difficult access.

Building stone
Granite gneiss exposed in the cliff 8 km northeast of Ts'o-kang station can be used as building stone. Because of its schistosity it is easily quarried.

GROUND WATER

The map area is situated in the Hulunbaierh-Gobi desert, and ground water occurring in the Quaternary deposits is more or less saline.
(1) Hailar: Three aquifers are found in Hailar town, occurring at the depths of 2 to 3 m, 20 to 30 m and 58 m respectively. Water of the first aquifer, which consists of thin porous sand and gravel beds, is not good quality, but water of the second aquifer, which consists of fine sand, is generally fit to drink.
(2) Flood plain south of Hailar: Aquifers of this area are as follows:

Hai-tun(西屯), east end of town	2.2 m	(drinkable)
Hsi-tun, central street	3.0 m	(drinkable)
Wu-chien-fang(五間房)	2.7 m	(not drinkable)
Wu-chien-fang	2.5 m	(not drinkable)
Liu-chien-fang(六間房)	2.4 m	(drinkable)
Yao-lu-tzu	1.9 m	(drinkable)
1.5 km north of Yao-lu-tzu	2.8 m	(drinkable)

(3) Hill south of the Hailar River: Aquifers occur at depths from 2.7 to 17.4 m. Water is thought to have permeated from the river. A shallow aquifer is exposed on the shore of a lake near Wilta-Burta.
(4) Hill eastern of Hailar: A drillhole 5 km east of Hailar revealed an aquifer at a depth of 26.8 m.
(5) Hill northern of Hailar: a drillhole 6 at Ta-liang-shang, 17 km north of Hailar, revealed an aquifer at the depth of 3 m.
(6) Neighborhood of Obön Pass between Kan-ching-tzu and Garösu: An aquifer occurs at the depth of 2 to 2.5 m. Water is abundant and good in quality.
Several springs of good water are found along the valley of So-erh-po-k'o-kuo(蘇爾博克谷).

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