GEOLOGIC COLUMN AND UNIT DESCRIPTION

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN
QUATERNARY	Alluvium (Qal)	Sand, clay and gravel; thickness less than 15 meters
	UNCONFORMITY	
	Diluvium (Qdg)	Sand, clay and gravel; thickness 20 to 40 m
	UNCONFORMITY	
TERTIARY	Neogene formation (Tu)	Shale, sandstone, conglomerate, bentonite and lignite; thickness unknown
	UNCONFORMITY	
	Neogene basalt (B2)	Flows of doleritic augite-olivine basalt
	EFFUSIVE CONTACT	
	Paleogene formation (Tl)	Upper coal-bearing bed, consisting of shale, sandy shale, sandstone and coal; thickness 25 m Sandstone bed, consisting of arkosic sandstone and conglomeratic sandstone; thickness 100 m Lower coal-bearing bed, consisting of shale, coal, coaly shale and sandy shale; thickness 20 m
	UNCONFORMITY	
MESOZOIC	Cretaceous andesite (Mkə)	Intermediate to basic effusive rocks
	EFFUSIVE CONTACT	
	Cretaceous rhyolite (rh)	Acidic effusive rocks
	EFFUSIVE CONTACT	
	Upper Cretaceous formation (Mku)	Sandstone and shale; thickness 30 m or more
	UNCONFORMITY	
	Quartz porphyry (qp)	Quartz porphyry, granite porphyry and rhyolite
	INTRUSIVE CONTACT	
	Pre-Jurassic granite (gz)	Biotite granite and biotite-hornblende granite

(Column not drawn to scale)

U N I T D E S C R I P T I O N

Alluvium is widely distributed in the drainage basins of the Amur River and its tributaries, covering low terrace remnants and flood plains. It is generally covered by marshes characterized by black muck, 0.3 to 0.5 m thick, owing to high ground water level. The upper part of the Alluvium consists of clay and sand, and the lower part consists of sand and gravel. The ground water level of the wells along the Amur River generally lies at a depth of 5 to 20 m from the surface. An enormous amount of water is obtainable as the water is closely related to the surface water level of the Amur River. The water is good in quality and contains no iron or manganese.

Diluvium is distributed along the Amur, the Zeya, and the Bureya rivers. It consists of yellowish brown sandy clay in the upper part, yellowish brown sand in the middle part, and sand and gravel in the lower part. The total thickness is 20 to 40 meters. Pebbles of the gravel are rounded quartzite and agate about 4 cm in diameter.

The Neogene formation is widely exposed in the northern and southern parts of the map area. It is a lacustrine deposit consisting of clayey shale, unconsolidated sandstone, and conglomerate, locally accompanied by lignite and bentonitic shale. Soviet geologists define the formation as a continental deposit of Pliocene age.

The Neogene basalt is overlain by Pleistocene deposits and the Neogene formation, and rests on the pre-Jurassic granite (ε_2). The basalt in the southwestern part of the map area forms a typical gently undulating lava plateau. The rock is dark gray to dark brown, coarse-grained, nonporous, holocrystalline and doleritic in texture, having no visible phenocrysts; the groundmass consists of microcrystalline augite and olivine. The basalt at Hsiao-tao-kan [下 道 砬] along the Amur River is black, vitreous and porous; under a microscope the groundmass is seen to contain fragments of augite and plagioclase.

The Paleogene formation, or Paleogene coal-bearing formation (NALIVKIN 1955), is exposed near Wu-yün [烏 雲], Manchuria and Raychikba, U.S.S.R. In Manchurian the formation is called the Wu-yün coal-bearing formation, and the stratigraphic sequence summarized from the records of drillholes and cuttings is as follows, in descending order:

(1) Upper coal-bearing bed, 25 m thick, consists of shale, sandy shale, fine-grained sandstone and a coal seam. The bed yields plant fossils such as Sequoia langsdorfii (Brongniart), Quercus sp., Fagus sp., and silicified wood.
(2) Sandstone bed, 100 m thick, consists of crossbedded arkosic sandstone and conglomeratic sandstone, containing silicified wood.
(3) Lower coal-bearing bed, 20 m thick, consists of shale, coal, coaly shale, blackish brown shale and gray sandy shale.

The formation is gently undulating, is unconformably overlain by the Neogene formation (Tu) and the Pleistocene deposits (Qdg), and rests upon the pre-Jurassic granite (ε_2) or the Upper Cretaceous formation (Mku). On the basis of plant fossils the formation is assigned to a Late Eocene to Miocene age.

Upper Cretaceous intermediate to basic effusive rocks, exposed exclusively in the U.S.S.R., are called Cretaceous andesite on this sheet.

Upper Cretaceous acidic effusive rocks, called Cretaceous rhyolite on this sheet, are exposed exclusively in the U.S.S.R. Available data are very few.

The Upper Cretaceous formation is exposed near Hsiao-ting-tzu [小 丁 子] and Mo-la-kuo-ch'i [莫 拉 果 奇], and is widely distributed in the northern part of the map area. The thickness is 30 m or more. The formation near Mo-la-kuo-ch'i consists of white to brown, coarse-grained quartzitic sandstone intercalated with grayish black tuffaceous shale in the lower part. The sandstone locally contains marcasite nodules and some pebbles 0.8 to 1 cm in diameter. Pebbles are granite, granite porphyry, andesite porphyry, schist, quartz and agate. The formation lies nearly horizontally or dips at about 5°.

Quartz porphyry near Ch'i-k'o is light brown to grayish black, microlitic and granitic in texture. Some of the map unit is rhyolitic flows consisting of glassy groundmass and large phenocrysts of quartz and feldspar. It may be Cretaceous in age, judging from its lithology.

Pre-Jurassic granite (Paleozoic granite of Soviet geologists) is sporadically exposed along the Amur and the Bureya Rivers, forming flat hilly land. The rock is biotite granite or hornblende-biotite granite consisting of quartz, orthoclase, plagioclase, hornblende and biotite.

E C O N O M I C V A L U E

Gold

The alluvial deposits near Ch'e-lu [車 路] consist of a white sand bed 4 to 5 m thick underlain by a gold-bearing gravel bed 1.5 m thick. Placer gold was worked in 1936 by 300 workers.

Coal

The Wu-yün coal field extends 25 km from east to west and 1.3 km from north to south.

The Lower coal-bearing bed generally occurs beneath the lowland along the Amur River. It was once worked unsuccessfully owing to the low quality of the coal and to the river water. The coal seam in the inclined shafts near Wu-yün and also at 9.5 km southeast of Wu-yün is 0.3 to 0.8 m thick; it strikes N 40° W to N 40° E and dips 3° to 10° SW or SE, or is locally horizontal.

The Upper coal-bearing bed occurs in the hilly land 5 to 13 km southwest of the Amur River, and occupies an area of 560,000 sq. m. The coal seam is 5.9 m thick and has one or two partings of grayish brown shale 0.3 m thick. Both the hanging- and foot-walls are sandy shale, yielding plant fossils. The coal seam strikes N 40° - 70° E, dips 25° NW or SE or is locally horizontal.

The coal is yellowish brown lignite, and exfoliates into platy or scaly fragments when weathered. The following table shows the analytical results:

	Upper coal seam		Lower coal seam	
Moisture (%)	14.35	16.90	15.75	18.40
Ash (%)	4.20	17.84	6.29	6.95
Volatile matter (%)	34.23	40.05	34.18	37.96
Fixed carbon (%)	30.07	42.56	37.35	43.12
Sulphur (%)	0.71	0.93	0.13	0.37
Calorific value	4,433	5,325	4,220	4,512
Coking property	noncoking		noncoking	
Color of ash	light brown		light brown	
Specific gravity	1.31	1.42	1.45	1.51

The coal reserves as of 1941 estimated by S. SATŌ (IMAIZUMI, 1952) were as follows:

Area	Coal seam	Strike length	Dip length	Thickness	Probable reserves
Lowland	Lower coal seam	3,000 m	400 m	0.3 m	500,000 tons
Hilly land	Lower and upper coal seams	2,000 m	1,000 - 2,000 m	2.0 m	3,880,000 tons
				Total tonnage	4,380,000 tons

Bentonite

Layers of grayish blue bentonite, 0.6 to 1.2 m thick, are interbedded in the Paleogene sandstone in the cliff 8 km west of Wu-yün. The results of analysis are as follows:

Sample	Ignition loss	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
No. 1	9.92	62.38	22.15	3.09	0.74	1.18
No. 2	11.06	54.90	23.50	5.36	0.86	1.13

Building stone

The quartz porphyry near Ch'i-k'o and the biotite granite near Mo-la-kuo-ch'i are quarried as building stone and for irrigation ditch construction.

REFERENCES

IMAIZUMI, Rikizō, 1952, The Tertiary period of Manchuria, in Geology and mineral resources of the Far East, Manchuria, III-9a: Comp. Comm. Geology and Mineral Res. Far East, Tokyo Geog. Soc.

MONDEN, Shigeyuki, 1936, Survey report of the geology of the route between Ch'i-k'o-te [奇 克 特] and Fu-yuan [撫 遠] along the Amur River: Unpub. rept., Geol. Inst., S. Manchuria Ry. Co.

NALIVKIN, D. V., editor, 1955, Geological map of U.S.S.R., scale 1:5,000,000: U.S.S.R. Ministry of Geology.

SAITŌ, Rinji, compiler, 1940, Geological map of Manchuria and adjacent areas, scale 1:3,000,000: Manchoukuo Geol. Inst.

USHIMARU, Shūtarō, and others, 1937, Geology and geography of northern Manchuria: Geol. Inst., S. Manchuria Ry. Co.