

GEOLOGIC COLUMN AND UNIT DESCRIPTIONS

AGE	ROCK UNIT	LITHOLOGY, THICKNESS WHERE KNOWN	UNIT DESCRIPTION	ECONOMIC VALUE	REFERENCES	
QUATERNARY	Alluvium	Sand, gravel, and clay; thickness less than 10 meters.	Alluvium consisting of recent sand, gravel, and clay covers low terrace remnants and fluvial plains, and attains a maximum thickness 10 meters.	Placer gold ① 21-	Geological Institute of South Manchuria Railway Co., 1938, Geology and Geography of the Northeastern Manchuria.	
	Diluvium	Sand, gravel, and clay; thickness less than 20 m.	Diluvium consisting mainly of coarse sand and gravel, with some clay, covers high terrace remnants, and also occurs as Pleistocene detritus; the basal gravel is occasionally surficial.	① 21-	KIRITANI, Fumio, 1951, Geologic structure of the Kuang-i coal field (unpublished manuscript).	
TERTIARY	~~~~~~Uncertainty~~~~~					
	Neogene basalt	Flows of basalt with tuffaceous sand and gravel; thickness less than 300 m.	Neogene basalt with a thickness varying from several to 300 m consists of flows of basalt in association with tuffaceous sand and gravel. The basalt widely distributed in the western half of the map area in a north-northeast direction can be divided into the northern and southern parts by a line connecting Mu-leng (穆棱) and Ta-ling (塔子沟) on the Chinese Changchun Railway (图 R 8 图 21). The northern part is the dissected lava plateau covering the older rocks comprising the Mesozoic coal measures, and granitic rock and gneiss. The basalt of this northern part is black to dark gray, compact, and shows a rather vitreous aspect on account of an absence of larger phenocrysts; phenocrysts are olivine, labradorite and some augite. The southern part is the so-called lava plateau of the Eastern Miao-chiang (图 R 11) basin, and the basalt is mainly titanite-olivine-doleritic basalt with locally gabbroic appearance. South of Tung-ming (图 R 7) several basalt mesas are developed constituting the north end of the basalt plateau on the Russo-Manchurian border described in the Tung-hsing-chang sheet (图 52-1). The by basalt might have been deluged by mass eruptions at different times during the Miocene - Pleistocene epochs to cover old peneplains.		NAGAO, Suteichi, 1952, Mi-shan coal field, Tung-an (图 R 7) Province: Compilation Committee, Geology and Mineral Resources of the Far East, Tokyo Geog. Soc. NALEYEN, D. V., 1955, Geologic map of U.S.S.R.: Ministry of Geology U.S.S.R. ŌKI, Kenichi, 1952, Kuang-i coal field of Lei-feng-tsun (图 R 11), Mu-leng Hsien (图 R 8); Compilation Committee, Geology and Mineral Resources of the Far East, Tokyo Geog. Soc. SATO, Shinji, 1950, Geologic map of Manchuria and adjacent areas, at scale 1:1,000,000. Geol. Survey of Manchoukuo. YAMAGUCHI, Shiro, 1936, Geologic report of the district around the andesite deposit of Hsiao-shi-fen (图 R 21), Tung-ming Hsien (图 R 5), Pin-chiang (图 R 1) Province (unpublished report of the South Manchuria Railway Co.).	
	Neogene beds	Tuffaceous sand and gravel; thickness less than 20 m.	The Neogene beds are represented by tuffaceous sand and gravel lying below the basalt by, and are distributed mainly west and south of Mu-leng in Manchuria. The beds are considered to be the lower part of the Neogene formation, and their thickness is less than 20 m. In the USSR a wide distribution of the Neogene beds is known in a district north of Grodekovo, but no descriptive data are available.			
	~~~~~~Uncertainty~~~~~					
	Andesite	Augite andesite, hornblende andesite, and pyroclastic rocks; thickness 200-300 m.	The andesite unit comprises Cretaceous to Tertiary andesitic lava flows accompanied by lava-agglomerate and tuff, and is 200 to 300 m thick. It is distributed mainly in the upper reaches of the Sui-fen Ho (图 R 11), and in a small area between Mu-leng and Ma-chia-ho-tzu (图 R 11) on the east bank of the Mu-leng Ho (图 R 11). In the upper Sui-fen Ho district the andesite, covering the Sungari series (Mn) and the Lower volcanic complex (Mv), forms hilly land of an old age topography. Andesite of this district generally shows a porphyritic structure. The phenocrysts are mainly andesite with a small amount of augite, and groundmass is either fine-textured or vitreous, occasionally with a flow structure. Andesite of the Mu-leng basin is mainly hornblende andesite with lava-breccias, and overlies the granite (g <sub>2</sub> ) and the Jurassic beds (Mj <sub>1</sub> , Mj <sub>2</sub> , Mj <sub>3</sub> ), and underlies the basalt (b <sub>2</sub> ). Dikes and intrusive sheets of hornblende andesite are found in the adjacent Mesozoic rocks.			
	Sungari series (Tuffaceous Nikon)	Tuff, diabasic volcanic agglomerate, tuffaceous sandstone, and conglomerate; thickness 300 to 400 m.	The Sungari series (图 R 11) occurs mainly in the basins of Mu-leng Ho and the upper Sui-fen Ho. In the Mu-leng Ho basin, the series consists mainly of reddish tuffaceous shale and sandstone, associated with some andesitic detrital rock, and dips gently to west. The thickness is estimated as 300 to 400 m. A similar red formation in the vicinity of the Sui-fen Ho station is covered by flows of andesite (a). The Sungari series in the upper Sui-fen Ho basin, USSR, is the so-called Tuffaceous Nikon which was studied by A. KOZLOFF (1921) who showed the descending sequence as follows: (c) variegated tuff containing Podocarpites and Equisetites (125 - 150 m thick), (b) flows of diabase accompanied by volcanic agglomerate (50 - 60 m thick), and (a) tuffaceous sandstone and conglomerate (125 - 160 m thick). The Sungari series is generally considered as the Upper (or Middle) Cretaceous.			
~~~~~~Uncertainty~~~~~						
Huashan series	Volcanic detritus, sandstone, and conglomerate; thickness 400 to 700 m.	The Huashan series (图 R 11) occurs mainly in the basin of Mu-leng Ho. In the Tai-tsoo-kou (图 R 11) district of the basin the series consists in descending order of San-feng (图 R 11) sandstone beds (over 200 m thick) and the Shih-hsing (图 R 11) conglomerate beds (250 to 350 m thick), with a total thickness 450 to 550 m. The Huashan series is correlated with the Talatu series (图 R 11) of Chientao (图 R 1) Province which has been generally considered to be the Lower Cretaceous.				
~~~~~~Probable uncertainty~~~~~						
Tungning series (Arkoze Nikon)	Sandstone, conglomerate, and coal-bearing shale; thickness 400 to 700 m.	The Tungning series (图 R 11) or the Arkoze Nikon occurs mainly in the basin of upper Sui-fen Ho. According to KOZLOFF (1921) the descending sequence of the Arkoze Nikon of the Soviet region is as follows: Arkoze sandstone formation (375 - 400 m thick) (3) Coal-bearing sandstone and shale beds intercalated with 3 to 4 seams of coal, containing plant fossils (100 - 125 m) (2) Soft sandstone beds with marked false bedding (125 m) (1) Conglomerate beds with sandstone bands (150 m) Basal conglomerate (thickness not given) Fossils reported by KOZLOFF include Marchantiales yabei Kryzstofovich, Equisetites yokoyamai Seward, Gonyozonites elongatus (Seward), Gonyozonites sp. (Seward), Gonyozonites sp. (Parker) (Sphenopteris), Cladophlebis browniana (Dunker), C. lobifolia (Phillips), C. suliformis Kryzstofovich, Dictyozonites inlectus (Morris), Osmia orientalis Hoer, Sphenopteris sp., Sphenopteris sp., Diocoonites Krynitzkyi Kryzstofovich, Gankia sp., Ptiloviridium contorta Hoer, Wilsfordia orientalis Hoer, Oligonites denticulatus Kryzstofovich, Ptiloviridium nordenskiöldi (Hoer), Platocladus subannulatus (Weller), Baiera annulata (Lindley et Butcher), Adiantites sowerbii (Hornem), Platocladus subannulatus (Weller), Baiera annulata, Rodites williamsoni (Fronquist), and Sphenopteris sibirica (Fronquist). The Arkoze Nikon was correlated by KOZLOFF to the Upper Cretaceous, but Japanese geologists including S. NITA have lately correlated the Tungning series, or its counterpart in Manchuria, to the uppermost Jurassic.	Coal ① 21- ① 21- ① 31-	Coal field of the upper Sui-fen Ho basin, USSR. According to a Russian source (1926) the coal field occupies a broad triangle area with Pandejovko, Lipovtsy and Nikolok as apex in the west, east and south. Its areal extension is 2,000 sq. miles (Russian). The coal is a low-grade bituminous coal, and the reserves are estimated at 700 million tons. Liu-shu-ho-tsu (图 R 11) in the Wu-ho-lin Ho basin where old native coal pits are found. Kuang-i coal field is 30 km east-west and 20 km north-south. Kuang-i-tun is situated nearly in the center. The Tai-tsoo-kou coal-bearing area occupies the southern half of the coal field. The coal field has estimated reserves of 332 million tons. Railway embankment was constructed in 1945, just before the end of the World War II, for a distance of 12 km between the Chi-ning - Hsiao-cheng-tze (Hsiao-cheng-tze on map) Railway and Kuang-i-tun. The mining operation was started in the northern part of the coal field.		
Mishan series	Sandstone, conglomerate, tuffaceous shale, and coal-bearing shale; thickness about 780 m.	The Mishan series (图 R 11) occurs mainly in the Tai-tsoo-kou district west of the Chi-ning - Hsiao-cheng-tze (Hsiao-cheng-tze on map) Railway. Primarily Kenichi (1951) subdivided the Mishan series in the vicinity of Kuang-i-tun (图 R 11) (Long. 130° 20' E, Lat. 45° N) into (3) Lei-feng (图 R 11) coal-bearing beds (600 m thick), (2) Ku-shan (图 R 11) conglomerate and sandstone beds (180 m thick), and (1) Kuang-i (图 R 11) coal-bearing beds (150 m thick), in descending order. Of which (3) and (2) will be correlated to the so-called Mishan formation, and (1) to the Mishan formation. According to Fumio KIRITANI, the exposures of the Mishan series south of the Tai-tsoo-kou River can be roughly correlated to the upper or the Mishan formation. The sequence of the Mishan formation of that area in descending order is as follows: Lei-feng coal-bearing beds, 600 m thick, consist of sandstone and shale intercalated with more than 10 seams of coal, of which the lower 3 seams are workable. Ku-shan conglomerate and sandstone beds, 180 m thick, consist of coarse sandstone and conglomerate, and unconformably overlies the granitic bed rock. Abundant plant fossils were collected from the Mishan series which is predominantly distributed in the Mishan coal field and Mu-leng coal field, none of the new studied by Russian and Japanese geologists. The Mishan series is now generally assigned to the Upper Jurassic. The coal-bearing formation in the basin of Wu-ho-lin Ho (图 R 11) is considered the Upper Mishan series.				
~~~~~~Probable uncertainty~~~~~						
Lower volcanic complex (Porphyrite)	Andesite, dacite, and pyroclastic rocks; thickness about 400 m.	Lower volcanic complex is composed mainly of flows and sheets of lavas of intermediate composition, occasionally accompanied by their pyroclastic rocks. As they are the "older" andesite lavas characterized with porphyritization, they have also been called "porphyrite". In the southern part of the map area Mv consists of andesite and dacite, and has a thickness 400 m. It underlies Mj <sub>2</sub> of the upper Sui-fen Ho basin. Mv distributed east of Sui-yung-chieh (图 R 11) in the central part of the map area underlies Mj <sub>2</sub> and is intercalated with lavas of Mv might have been erupted prior to Mj <sub>1</sub> and Mj <sub>2</sub> , and probably after the intrusions of g <sub>1</sub> , d, and g <sub>2</sub> .				
~~~~~~Uncertainty~~~~~						
Quartz porphyry	Quartz porphyry and granite porphyry.	Quartz porphyry, including granite porphyry, occurs in the district of Chin-chang (图 R 11). The rock may be an acidic marginal facies of g <sub>2</sub> .	Gold veins ① 31-	Three old gold pits working on gold-bearing quartz veins are located east of Chin-chang village. The quartz porphyry suffered propylitization near the veins.		
Diorite	Diorite and granodiorite.	Diorite is found adjacent to qp east of Chin-chang, and also in the district east of Tung-ming. It may be a basic marginal facies of g <sub>2</sub> .				
Pre-Jurassic granite	Biotite granite and hornblende-biotite granite, with local gneiss and schist.	Granite might have been placed during the Triassic period, because it contact-metamorphosed P <sub>1</sub> and is generally covered by Mj <sub>1</sub> with an erosion surface between biotite granite and hornblende-biotite granite, and is more or less marked by foliated structure. In some places g <sub>2</sub> is hardly distinguishable from gn.	Building stone ① 31-	In the vicinity of Sui-yung-chieh the biotite-granite is quarried as building stone.		
~~~~~~Intrusive contact~~~~~						
PALEOZOIC	Upper Paleozoic formation	Spotted shale, graywacke, hornfels, crystalline limestone, tuffaceous marl, schist and injection gneiss.	Upper Paleozoic is a contact-metamorphosed marine formation of which thickness is not known. Although no detailed study was made on this formation, it is generally considered as the northern extension of the so-called "Tungning formation" (图 R 11) of the southern Chientao (图 R 1) Province. This formation consists of spotted shale, graywacke and cordierite-chlorite-mica hornfels, locally accompanied by injection gneiss. The formation probably includes rocks of various ages ranging between Carboniferous and Permian. It is hardly distinguishable from the schist (Sch) of unknown age, so the problem whether or not they belong to different units remains unsolved.			
AGE UNKNOWN	Gneiss	Biotite metagneiss, hornblende metagneiss, augen gneiss, biotite orthogneiss, with local schist.	Gneiss consists chiefly of biotite-metagneiss, hornblende-metagneiss, augen gneiss. These rocks may have been formed by injection of granite (g <sub>2</sub> ) into either Paleozoic rocks or crystalline schist (Sch). Biotite orthogneiss with a similar mineral composition to g <sub>2</sub> is also common. Gneiss occurs mostly in the Wu-ho-lin Ho basin. Some assign the gneiss to Precambrian, but the basis for such an age designation requires further discussion.			
	Schist	Quartz-mica schist, chlorite-mica schist, crystalline limestone, chlorite-albite-mica schist, garnet-albite-mica schist, and hornblende.	Crystalline schist is distributed in three districts, two in the northern part of the mapped area and one in the southern margin. The eastern one of the two northern exposures stretches northward across the Russo-Manchurian border-line beyond the Gora Tencun, and the western one occurs in Hsiao-cheng-tze district in the Mu-leng Ho basin. The southern zone in the district of Eri-shih-pa-tao-ho-tzu (图 R 11) is traceable southwesterly as far as the Lo-tsoo-kou (图 R 11) basin of the Tung-hsing-chang sheet (图 52-3). The rocks of the northern zones are chiefly quartz-mica schist, chlorite-mica schist, and chlorite-albite-mica schist, locally intercalated with hornblende, crystalline limestone and garnet-hornblende-solite-mica schist, while the southern zone is reported to be mostly garnet-albite-mica schist. The crystalline schist generally shows marked uniformity in the degree of metamorphism, and it may be the product of a regional metamorphism. In the latest Russian geologic map (1955) the schist zone on the Russo-Manchurian border-line is divided into "Upper Proterozoic or Lower Cambrian (Fr <sub>2</sub> , Cm <sub>1</sub> )", and "Proterozoic (Fr)".			

(Column not drawn to scale)