

GEOLOGIC COLUMN AND UNIT DESCRIPTIONS

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION																
QUATERNARY	Alluvium	Clay, sand and gravel; thickness less than 10 meters	The surface soil of the map area is the characteristic "tschernosen", 0.5 m to 2 m thick, consisting chiefly of fertile black muck. It is better for agriculture than the fluvial soils of Japan. Alluvium, consisting of clay, sand and gravel, is distributed in the drainage basins of the No-mo-erh Ho (諾爾河), the Wu-yi-erh Ho (烏爾河), and the Chan Ho (占河), covering vast flood plains and low terrace remnants. It often forms marshes due to the high ground water table.																
	UNCONFORMITY																		
		b ₃₋₄ : new cone lava; thickness 50 to 100 m	The Quaternary basalt is widely distributed in the northwestern part of the map area. It includes five phases, b ₃₋₁ , b ₃₋₂ , b ₃₋₃ , b ₃₋₄ . The oldest of these phases, b ₃ , rests on the Mesozoic, the Tertiary and the Pleistocene deposits, showing a gently sloping landform. The rock is a grayish black to grayish brown, compact, olivine basalt. Olivine occurs as phenocrysts. Principal minerals are anorthoclase, plagioclase, olivine, augite, magnetite and glass, occasionally accompanied by biotite and titaniferous minerals. The rock is fine-grained, holocrystalline to holohyaline, and has an intersertal or radial texture. The chemical composition (%) of the basalt in the hilly land of Shih-tou-fang-tzu (石頭房子) is: SiO ₂ , 50.54; TiO ₂ , 2.05; Fe ₂ O ₃ , 2.31; FeO, 7.41; MnO, 0.15; CaO, 7.01; Na ₂ O, 3.57; K ₂ O, 4.28; P ₂ O ₅ , 1.06; H ₂ O, 0.69; and the specific gravity is 2.86. Overlying b ₃ are several areas of shield basalt (b ₃₋₁), constituting several gently sloping elliptical shields which are 10 to 20 sq km in area and 100 to 140 m above the surrounding hilly land. The rock is a grayish black, scoriaceous olivine basalt without megascopic phenocrysts. On these shields are eleven cones from which the old cone lava (b ₃₋₂) erupted. The old cone lava consists chiefly of augite, olivine and glass, in association with anorthoclase, leucite and magnetite. The lava was named "shihlunite" * by T. OGURA (1936). The lava can be classified into the following four types by mineral composition: 1) shihlunite, olivine, augite, glass; 2) leucite shihlunite, olivine, augite, leucite, glass; 3) anorthoclase shihlunite, olivine, augite, anorthoclase, glass; 4) anorthoclase-leucite shihlunite, olivine, augite, anorthoclase, leucite, glass. The chemical composition (%) of the anorthoclase shihlunite at east Lung-men Shan (龍門山) follows: SiO ₂ , 47.15; TiO ₂ , 2.45; Al ₂ O ₃ , 14.27; Fe ₂ O ₃ , 9.32; FeO, 1.44; MgO, 7.78; MnO, 0.18; CaO, 8.32; Na ₂ O, 3.23; K ₂ O, 4.56; P ₂ O ₅ , 1.07; H ₂ O, 0.79; and specific gravity 2.85. The lava at K'o-tung (高東) is a gray, fine-grained, locally vesicular leucite basanite of the shihlunite type. It consists essentially of microphenocrysts of olivine and leucite, with a groundmass of anorthoclase, augite, mica-ilmenite and biotite. The old cone lavas are overlain by the Shihlung lava (b ₃₋₃) which is exposed at Shihlung in the Wu-ta-lien-ch'i (五通地) district. The lava is pitch-black to bluish black, glassy, lustrous, generally compact on the surface but scoriaceous inside. It is composed of microphenocrystic or microlitic olivine, microlitic augite and much glass, with occasional leucite. Many quartz grains and garnet fragments occur as xenoliths. The rock includes a new type of rocks which is monzonitic in texture. The following chemical compositions (%) show that the rock is a basic alkaline type: SiO ₂ TiO ₂ Al ₂ O ₃ Fe ₂ O ₃ FeO MgO MnO CaO Na ₂ O K ₂ O P ₂ O ₅ H ₂ O Total Sp. gr. (1) 52.68 1.88 14.38 1.43 7.76 6.38 0.15 5.82 3.36 5.43 1.10 0.11 100.48 2.69 (2) 52.94 2.00 14.69 0.89 8.05 6.08 0.15 6.01 3.35 5.13 1.01 0.32 100.62 2.69 * (1) collected from an old vent on the northern foot of Lao-hei Shan (老黑山), and (2) from Shih-tou-fang-tzu, not shown on the map, about 13 km south of locality (1). The new cone lava (b ₃₋₄) overlies the Shihlung lava and is exposed at Lao-hei Shan and Hsu-shao Shan to the northeast (not on map) and constitutes typical konike volcanoes. The lava is porous or scoriaceous, consisting of olivine, augite, glass and occasionally leucite. The chemical composition (%) follows: SiO ₂ , 50.81; TiO ₂ , 2.19; Al ₂ O ₃ , 14.71; Fe ₂ O ₃ , 2.35; FeO, 6.20; MgO, 7.43; MnO, 0.14; CaO, 6.65; Na ₂ O, 3.56; K ₂ O, 5.21; P ₂ O ₅ , 1.06; H ₂ O, 0.29; and specific gravity 2.69. The cone lavas probably correspond to b ₃₋₂ on the Sun-wu sheet (NM 52-7) to the north. * "Shihlunite" took the name from Shihlung (meaning stone dragon) where there are lava flows of peculiar shape resembling crawling dragons.)																
		b ₃₋₃ : "Shihlung" lava; thickness less than 20 m																	
		b ₃₋₂ : old cone lava; thickness more than 100 m																	
		b ₃₋₁ : shield lava; thickness 5 to 50 m																	
		b ₃ : olivine basalt; thickness 50 to 100 m																	
	EFFUSIVE CONTACT																		
		Diluvium	Clay, sand and gravel; thickness less than 100 m	Diluvium, distributed southwest of the No-mo-erh Ho, comprises two parts; the upper part consists chiefly of clay and sand, and the lower part of sand and gravel. Three drillholes revealed the following sequences in descending order (thickness in meters):															
				<table border="1"> <thead> <tr> <th></th> <th>Lung-chen (龍陳)</th> <th>Pei-an (北安)</th> <th>T'ung-pei (通北)</th> </tr> </thead> <tbody> <tr> <td>Upper (43.9m)</td> <td>Black soil 1.2 Yellow clay 6.3 Green mud 3.5 Green clay 3.5 Gray soft clay 29.4</td> <td>Black soil 1.0 Gray clay 3.6 Pebbly sand 1.5 Gray clay 8.0 Gray hard clay 21.8</td> <td>Black soil 1.0 Bluish gray clay 12.8 Fine sand 2.2 Gray clay 26.0 Fine sand 1.0</td> </tr> <tr> <td>Lower (16.4m)</td> <td>Fine sand 3.0 Clay 1.5 Fine sand 1.8 Clay 1.5 Fine sand 8.6</td> <td>Clay and gravel 2.7 Clay with wood fragments 2.5 Clay 4.0 Fine sand 4.3 Clay 4.0 Fine sand 2.0 Sandy clay 5.8</td> <td>Upper (89.8m) Gray hard clay 30.5 Fine sand 4.7 Clay 3.8 Fine sand 1.5 Clay 1.0 Fine sand 5.3</td> </tr> <tr> <td>Total</td> <td>60.3</td> <td>61.2</td> <td>89.8</td> </tr> </tbody> </table>		Lung-chen (龍陳)	Pei-an (北安)	T'ung-pei (通北)	Upper (43.9m)	Black soil 1.2 Yellow clay 6.3 Green mud 3.5 Green clay 3.5 Gray soft clay 29.4	Black soil 1.0 Gray clay 3.6 Pebbly sand 1.5 Gray clay 8.0 Gray hard clay 21.8	Black soil 1.0 Bluish gray clay 12.8 Fine sand 2.2 Gray clay 26.0 Fine sand 1.0	Lower (16.4m)	Fine sand 3.0 Clay 1.5 Fine sand 1.8 Clay 1.5 Fine sand 8.6	Clay and gravel 2.7 Clay with wood fragments 2.5 Clay 4.0 Fine sand 4.3 Clay 4.0 Fine sand 2.0 Sandy clay 5.8	Upper (89.8m) Gray hard clay 30.5 Fine sand 4.7 Clay 3.8 Fine sand 1.5 Clay 1.0 Fine sand 5.3	Total	60.3	61.2
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UNCONFORMITY																			
	Neogene formation	Shale, sandstone and conglomerate; thickness 100 to 200 m	The Neogene formation is distributed in the area northeast of the No-mo-erh Ho. It consists of clayey shale, soft sandstone and unconsolidated conglomerate, with bentonitic shale. The formation along the No-mo-erh Ho looks like a Pleistocene deposit, but along the Chan Ho it forms dissected valleys composed of harder rocks. The formation on the hill 4 km east of Pei-an consists of gray or light grayish green friable sandstone and light gray or dark gray soft shale, containing abundant Corbicula sp. It strikes N 60° W and dips 15° SW. The formation is covered by the Pleistocene deposit and rests on the Neogene basalt (b ₃), the Cretaceous rhyolite (rh), and the pre-Jurassic granite (g ₂); it may be correlated with the Neogene formation along the Hei-lung Chiang (黑龍江).																
	Neogene basalt	Doleritic basalt; thickness more than 100 m	Neogene basalt is exposed in the northeastern part of the map area, forming a typical gently undulating lava plateau. The rock is dark gray to dark brown, coarse-grained, and non-porous when fresh. It is generally holocrystalline and doleritic; the groundmass contains microcrystalline augite and olivine.																
EFFUSIVE CONTACT																			
	Cretaceous rhyolite	Flows of rhyolite; thickness unknown	The Cretaceous rhyolite occurs as flows sporadically exposed in the vicinity of Kar-tei (not shown on map) along the Chan Ho. The rock is light gray, and contains round quartz phenocrysts, 1.5 mm in diameter, and orthoclase phenocrysts which are generally weathered to yellowish brown clay. The groundmass is gray, compact, and has a glassy luster.																
EFFUSIVE CONTACT																			
	Lower Cretaceous formation	Clay, shale and sand; thickness more than 30 m	The Lower Cretaceous formation, consisting of clay, shale and sand, is exposed at Wu-ta-lien-ch'i, Pei-an, and T'ung-pei. Because of the occasional Estheria fossils in the shale, the age of the formation is assigned to Lower Cretaceous. Residual deposits of pyrite are found in the decomposed soil of the Cretaceous formation. Pyrite occurs as concretions, 5 to 15 cm in diameter, but is not workable as the quantity is small and access is difficult.																
UNCONFORMITY																			
	Diorite		The diorite constituting Eih-lung Shan (二龍山) is dark gray to dark green, hard and compact. It is associated with a hornblende gneissose rock which seems to have been metamorphosed by the diorite intrusion. The diorite is probably a marginal facies of the pre-Jurassic granite (g ₂).																
	Pre-Jurassic granite	Biotite granite, hornblende-biotite granite, two-mica granite and lepidolite granite	The pre-Jurassic granite is exposed in three areas: (1) Wu-ta-lien Ch'i: The granite shows three different modes of occurrence, a) as bedrock, which is white or reddish biotite granite or two-mica granite; b) as xenoliths, white, scoriaceous and nodular, 1 to 3 cm in diameter, in the Shihlung lava, and c) as ejecta in the Lao-hei-shan lava. (2) The hills east of Eih-lung Shan and Feng-huang Shan (鳳凰山): The rock is a pinkish brown, compact, medium-grained, garnet-bearing hornblende-biotite granite. (3) Mountains west of the Chan Ho: The granite occurs as a batholith beneath the Neogene formation (Tu), and is sporadically exposed in a north-south direction. The rock is chiefly hornblende-biotite granite, locally is two-mica granite, and rarely is lepidolite granite.																
INTRUSIVE CONTACT																			
	Paleozoic formation	Clay slate and graywacke; thickness unknown	The Paleozoic formation, exposed in the hills northeast of Lung-chen, consists of black clay slate and graywacke. The formation in the cliff along the Chan Ho, 40 km south of the junction with the Tu-lu Ho (都魯河) consists chiefly of purplish dark gray crystalline graywacke.																
	(Column not drawn to scale)																		

GROUND WATER

Ground water of the map area is unfit for drinking, as is indicated by the chemical analyses (by S. Manchuria Ry. Co. in 1934) in the table below. The ground water level in the Recent fluvial deposits along the No-mo-erh Ho and Wu-yi-erh Ho is shallow, 5 to 10 m below the surface. The aquifer is an alluvial gravel bed overlying the Pleistocene impermeable clay bed. The water is abundant but is poor in quality as river water enters the aquifer. Ground water in the Pleistocene terrace deposits occurs in the following aquifers: (1) At K'o-tung, an aquifer consisting of coarse to medium-grained quartz sand with chalcedony pebbles lies at a depth of between 10 m and 20 m. The discharge of water is 50 to 80 tons a day. (2) In the area between Pei-an and Lung-chen, the Pleistocene deposits contain 2 to 6 aquifers as deep as 60 m. The beds consist of sand and gravel, interbedded in thick clay. Amount of discharged water is 2 tons a day from a well 60 m deep at Pei-an and 2.7 tons a day from a well 8 m deep at Lung-chen. (3) Inside the town-wall of T'ung-pei, an aquifer is found at a depth between 17 m and 26 m. Interbedded within a thick clay bed, the layer is 5 cm to 5 m thick, and consists of yellowish brown fine-grained sand with gravel, containing much ferruginous substance.

Type of well	Depth (m)	Turbidity	Odor	Reaction	Quantitative analysis										Hardness (German degree)	Volatile matter	Bacteria (per lit.)	Remarks
					Cl	SO ₂	NO ₂	NO ₃	NH ₃	KMnO ₄	Fe	Mn						
Wood-frame well	10	Slightly turbid	Slight bad odor	Alkaline	7	50	15	n.d.	r.	18	---	1.7	5.1	---	---	Contains manganese		
"	16	"	Muddy odor	"	7	50	15	n.d.	tr.	21	8.0	0.8	5.1	---	---	Contains iron		
"	20	Turbid	"	"	4	50	15	n.d.	n.d.	22	17.0	0.5	5.5	200	---	Contains manganese and iron		
Cased well	60	Slightly turbid	Bad odor	Slightly alkaline	4	50	15	n.d.	ab.	8.2	7.0	1.3	9.0	249	---	" " " "		
"	60	"	"	"	7	50	15	n.d.	ab.	7.6	30.0	0.7	3.6	296	---	" " " "		
Wood-framed well	20	"	Slight bad odor	Alkaline	7	50	15	n.d.	n.d.	7.6	---	0.9	2.6	172	---	" " " "		
Cased well	40	"	Bad odor	"	7	50	15	n.d.	ab.	4.4	7.0	0.8	13.5	384	---	" " " "		
Chinese well	6.7	"	Muddy odor	Alkaline	7.1	n.d.	tr.	tr.	tr.	6.6	---	---	7.8	---	---	Impure		
Wood-framed well	14.2	Whitish	Slightly bitter	"	21.3	n.d.	tr.	n.d.	n.d.	---	---	---	5.6	---	---	"		
"	8.6	Turbid	"	Slightly alkaline	12.4	n.d.	tr.	n.d.	n.d.	---	---	---	4.8	---	---	"		
"	7.8	Whitish	Odorless	Alkaline	14.2	n.d.	ab.	n.d.	n.d.	---	---	---	---	---	---	"		
Cased well	84	"	"	Neutral	5	50	15	n.d.	tr.	8.2	17.0	0.8	3.5	133	---	Contains manganese and iron		
"	50	Slightly turbid	Slight bad odor	Alkaline	7	50	15	n.d.	r.	5.7	n.d.	n.d.	5.1	188	175	Impure		
Chinese well	20	Transparent	Odorless	"	11	50	15	n.d.	r.	7.0	n.d.	n.d.	3.1	232	390	"		

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