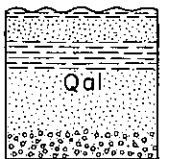

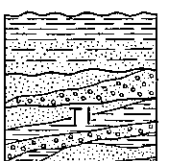
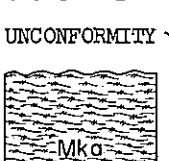
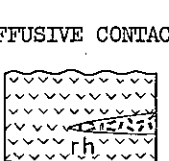

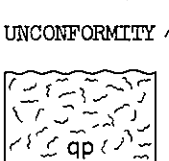
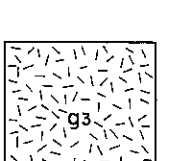
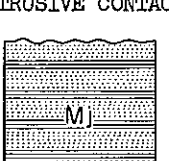
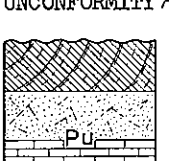
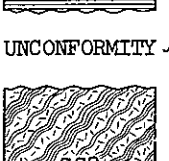


# GEOLOGIC COLUMN AND UNIT DESCRIPTION

AGE	ROCK UNIT	LITHOLOGY; THICKNESS WHERE KNOWN	UNIT DESCRIPTION	ECONOMIC VALUE	GROUND WATER																																																																																																																																																								
QUATERNARY	Alluvium	 Sand, clay, silt and gravel; thickness less than 10 meters	<p>Alluvium consists of sand, clay, silt and gravel of fluvial, aeolian or lacustrine origin. It is distributed in the drainage basins of the I-min Ho [伊敏河], the Rui Ho [洮儿河] the Ha-erh-ha Ho [哈爾河] and their tributaries, covering flood plains and low terrace remnants. The regions of the alluvial deposits are characterized by numerous playas and swamps. Some of the playas have no outlets, resulting in saline lakes, as seen in the vicinity of Yen Hu [鹽湖] which means "salt lake". The saline deposits on the bottom of such lakes are often as thick as 10 cm to 50 cm, composed of salt, sodium bicarbonate and sodium sulphate. The playas-lakes in the southwestern part of the map area, surveyed by T. KAWADA (1937) in July 1935, are listed below.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Name of lake (Native name)</th> <th>Distance (km) from Yen Hu</th> <th>Circumference (km)</th> <th>Area (sq. km)</th> <th>Depth (m)</th> <th>Salinity (%)</th> <th>Principal salts</th> <th>Remarks</th> </tr> </thead> <tbody> <tr> <td>Yen Hu (Pain Nor)</td> <td>0.2 S</td> <td>5.625</td> <td>1.407</td> <td>0.4</td> <td>25.65</td> <td>NaCl</td> <td>Horses will not drink</td> </tr> <tr> <td>Ha-la Hu (Baga Nor)</td> <td>1.4 SE</td> <td>1.550</td> <td>0.019</td> <td>0.8</td> <td>1.59</td> <td>NaCl, NaHCO<sub>3</sub></td> <td>dislike</td> </tr> <tr> <td>Borukku-nöru (Ho-jur Nor)</td> <td>2.5 SE</td> <td>4.250</td> <td>1.275</td> <td>1.7</td> <td>6.56</td> <td>Na<sub>2</sub>SO<sub>4</sub></td> <td>" will not drink</td> </tr> <tr> <td>Baruto-nöru (Bardo Nor)</td> <td>9.2 NNW</td> <td>4.500</td> <td>1.260</td> <td>0.8-2</td> <td>0.87</td> <td>NaCl, NaHCO<sub>3</sub></td> <td>" dislike</td> </tr> <tr> <td>Narin-nöru (Nari Nor)</td> <td>10.6 NNW</td> <td>3.500</td> <td>0.500</td> <td>--</td> <td>0.89</td> <td>NaCl, NaHCO<sub>3</sub></td> <td>" dislike</td> </tr> <tr> <td>Saidom-nöru (Saidm Nor)</td> <td>14.5 NNW</td> <td>5.700</td> <td>0.950</td> <td>0.5</td> <td>3.58</td> <td>NaCl, Na<sub>2</sub>SO<sub>4</sub></td> <td>" will not drink</td> </tr> <tr> <td>Zonshabur-nöru (Zaim Nor)</td> <td>8.2 W</td> <td>1.700</td> <td>0.200</td> <td>1</td> <td>0.16</td> <td>Mg(HCO<sub>3</sub>)<sub>2</sub>, NaHCO<sub>3</sub></td> <td>Drinkable</td> </tr> <tr> <td>Baronshabur-nöru (Ganga Nor)</td> <td>9 W</td> <td>1.800</td> <td>0.150</td> <td>1</td> <td>0.03</td> <td>---</td> <td>"</td> </tr> <tr> <td>Hun-ching Hu (Hontsin Nor)</td> <td>9.5 SW</td> <td>1.545</td> <td>0.117</td> <td>--</td> <td>0.03</td> <td>---</td> <td>"</td> </tr> <tr> <td>To-lu-han Hu (Talgin Nor)</td> <td>17.2 SSW</td> <td>6.750</td> <td>3.143</td> <td>--</td> <td>16.57</td> <td>NaCl, Na<sub>2</sub>SO<sub>4</sub></td> <td>Horses will not drink</td> </tr> <tr> <td>Bagasharaso Ho (Kaim Nor)</td> <td>20 SE</td> <td>7.650</td> <td>2.925</td> <td>--</td> <td>3.90</td> <td>NaCl, Na<sub>2</sub>SO<sub>4</sub></td> <td>will not drink</td> </tr> <tr> <td>Shesharaso Ho (Shalson Nor)</td> <td>19.3 SE</td> <td>4.650</td> <td>1.368</td> <td>--</td> <td>0.52</td> <td>NaCl, Na<sub>2</sub>SO<sub>4</sub>, NaHCO<sub>3</sub></td> <td>" dislike</td> </tr> <tr> <td>Arunzu Ho (Aranza Nor)</td> <td>15 SE</td> <td>0.600</td> <td>0.020</td> <td>--</td> <td>0.32</td> <td>NaCl, Mg(HCO<sub>3</sub>)<sub>2</sub></td> <td>" dislike</td> </tr> <tr> <td>Ha-la Hu (Ha-ra Nor)</td> <td>9.5 ENE</td> <td>5.200</td> <td>1.500</td> <td>0.2</td> <td>--</td> <td>---</td> <td>"</td> </tr> <tr> <td>Fai-yin-ch'a-ken Hu (Faintsagan Nor)</td> <td>15 NE</td> <td>13.000</td> <td>7.450</td> <td>--</td> <td>12.59</td> <td>NaCl, Na<sub>2</sub>SO<sub>4</sub></td> <td>Horses will not drink</td> </tr> <tr> <td>Oron-nöru (Oro Nor)</td> <td>28 NNW</td> <td>1.200</td> <td>0.093</td> <td>0.5</td> <td>20.43</td> <td>NaCl</td> <td>" will not drink</td> </tr> <tr> <td>Sume-nöru (Small Nor)</td> <td>30 NW</td> <td>1.550</td> <td>0.120</td> <td>1</td> <td>0.03</td> <td>---</td> <td>Drinkable</td> </tr> <tr> <td>Koroto-nöru (Gozoro Nor)</td> <td>43 NE</td> <td>3.500</td> <td>0.400</td> <td>--</td> <td>0.03</td> <td>---</td> <td>"</td> </tr> </tbody> </table> <p>Diluvium is divided into Q<sub>ass</sub> and Q<sub>ds</sub>.</p> <p>Q<sub>ass</sub> consists of aeolian dune sand of Pleistocene to Recent age, and is sporadically distributed in the southwestern part of the map area. Drillhole 5*, only 330 m east of Yen Hu, revealed the following sequence, with depths from the ground surface, in descending order: light brown fine quartz sand (0.75 m), dark brown fine quartz sand (0.75-1.25 m), light yellowish gray fine quartz sand with a small amount of silt (1.25-2.25 m +). Drillhole 6 in the vicinity of Man-chu-erh-miao revealed the following sequence: surface soil (0.4 m from the surface), brown silt and sand (0.4-2.6 m), desert sand (2.6-12.4 m), fine quartz sand with silt (12.4-31.9 m), brown clay (31.9 m +).</p> <p>Q<sub>ds</sub> is a Pleistocene deposit consisting chiefly of aeolian sand, associated with sand, silt and gravel, of fluvial origin. It is widely distributed throughout the whole map area, exhibiting an undulating landform. It is known as the Hilmunberh formation [呼倫貝爾組]. The aeolian sand is composed of quartz and feldspar grains. Four drillholes sunk into the sedimentary Pleistocene deposit revealed the following descending sequence. Depths are measured from the surface. No. 1 (27 km west of Ta-li-wang-chia): surface soil (0.2 m), brown clayey sand (0.2-1.77 m), yellowish brown clay (1.77-8.12 m), brown fine sand (8.12-20.7 m), deep brown clay (20.7-44 m). No. 2 (near Totsankai-obo): surface soil (0.4 m), sandy clay (0.4-3.2 m), white clayey sand with plant fragments (3.2-9.8 m), reddish brown gravelly clay (9.8-19.6 m). No. 3 (5 km north of Oron-nöru): surface soil (0.9 m), grayish white clay (0.9-4.9 m), blue clay with sand (4.9-12.5 m), black clay (12.5-17.0 m), fine gravel (17.0-18.3 m), brown clay (18.3 m +). No. 4 (at Talgan-shihle): surface soil (0.3 m), brown silt and sand (0.3-1.5 m), blue to white fine sand (1.5-4.3 m), clayey sand (4.3 m +).</p> <p>* Drillhole numbers correspond to sites shown on the map.</p>	Name of lake (Native name)	Distance (km) from Yen Hu	Circumference (km)	Area (sq. km)	Depth (m)	Salinity (%)	Principal salts	Remarks	Yen Hu (Pain Nor)	0.2 S	5.625	1.407	0.4	25.65	NaCl	Horses will not drink	Ha-la Hu (Baga Nor)	1.4 SE	1.550	0.019	0.8	1.59	NaCl, NaHCO <sub>3</sub>	dislike	Borukku-nöru (Ho-jur Nor)	2.5 SE	4.250	1.275	1.7	6.56	Na <sub>2</sub> SO <sub>4</sub>	" will not drink	Baruto-nöru (Bardo Nor)	9.2 NNW	4.500	1.260	0.8-2	0.87	NaCl, NaHCO <sub>3</sub>	" dislike	Narin-nöru (Nari Nor)	10.6 NNW	3.500	0.500	--	0.89	NaCl, NaHCO <sub>3</sub>	" dislike	Saidom-nöru (Saidm Nor)	14.5 NNW	5.700	0.950	0.5	3.58	NaCl, Na <sub>2</sub> SO <sub>4</sub>	" will not drink	Zonshabur-nöru (Zaim Nor)	8.2 W	1.700	0.200	1	0.16	Mg(HCO <sub>3</sub> ) <sub>2</sub> , NaHCO <sub>3</sub>	Drinkable	Baronshabur-nöru (Ganga Nor)	9 W	1.800	0.150	1	0.03	---	"	Hun-ching Hu (Hontsin Nor)	9.5 SW	1.545	0.117	--	0.03	---	"	To-lu-han Hu (Talgin Nor)	17.2 SSW	6.750	3.143	--	16.57	NaCl, Na <sub>2</sub> SO <sub>4</sub>	Horses will not drink	Bagasharaso Ho (Kaim Nor)	20 SE	7.650	2.925	--	3.90	NaCl, Na <sub>2</sub> SO <sub>4</sub>	will not drink	Shesharaso Ho (Shalson Nor)	19.3 SE	4.650	1.368	--	0.52	NaCl, Na <sub>2</sub> SO <sub>4</sub> , NaHCO <sub>3</sub>	" dislike	Arunzu Ho (Aranza Nor)	15 SE	0.600	0.020	--	0.32	NaCl, Mg(HCO <sub>3</sub> ) <sub>2</sub>	" dislike	Ha-la Hu (Ha-ra Nor)	9.5 ENE	5.200	1.500	0.2	--	---	"	Fai-yin-ch'a-ken Hu (Faintsagan Nor)	15 NE	13.000	7.450	--	12.59	NaCl, Na <sub>2</sub> SO <sub>4</sub>	Horses will not drink	Oron-nöru (Oro Nor)	28 NNW	1.200	0.093	0.5	20.43	NaCl	" will not drink	Sume-nöru (Small Nor)	30 NW	1.550	0.120	1	0.03	---	Drinkable	Koroto-nöru (Gozoro Nor)	43 NE	3.500	0.400	--	0.03	---	"	<p><b>NATURAL SALTS</b></p> <p>The map area belongs to a semi-arid region with an annual rainfall only 300 mm. Inland lakes without outlets result in saline playas. Natural salts collected from those lakes are common salt (NaCl), sodium sulphate (Na<sub>2</sub>SO<sub>4</sub>) and sodium carbonate (Na<sub>2</sub>CO<sub>3</sub>). Probable reserves of natural salts estimated by KAWADA at five lakes are as follows (unit in tons). Yen Hu (Pain Nor): NaCl (91,163), Na<sub>2</sub>SO<sub>4</sub> (28,888), Na<sub>2</sub>CO<sub>3</sub> (19,369); Borukku-nöru (Ho-jur Nor): NaCl (61,280), Na<sub>2</sub>SO<sub>4</sub> (29,175), Na<sub>2</sub>CO<sub>3</sub> (45,366); Tolu-han Hu (Tal-gan Nor): NaCl (779,037), Na<sub>2</sub>SO<sub>4</sub> (254,775); Fai-yin-ch'a-ken Hu (Pain-tsa-gan Nor): NaCl (414,927), Na<sub>2</sub>SO<sub>4</sub> (76,671); Oron-nöru (O-ro Nor): NaCl (7,267). Total reserves are 3,353,574 tons NaCl, 391,449 tons Na<sub>2</sub>SO<sub>4</sub>, and 64,735 tons Na<sub>2</sub>CO<sub>3</sub>.</p> <p>(1) Common salt: Chemical analysis of dark gray sandy silt of the bottom of Yen Hu showed the following composition in percentage. Southern coast: Na<sub>2</sub>CO<sub>3</sub>, 1.85; NaHCO<sub>3</sub>, 1.00; NaHCO<sub>3</sub>, 0.62; NaCl, 3.90; Na<sub>2</sub>SO<sub>4</sub>, 0.81; Western coast: Na<sub>2</sub>CO<sub>3</sub>, 1.85; NaHCO<sub>3</sub>, 1.33; NaCl, 3.38; Na<sub>2</sub>SO<sub>4</sub>, 0.74.</p> <p>Results of the ionic analysis for the light yellowish brown water of Yen Hu, of which salinity was 25.65% and water temperature was 31° C as of July 5, 1935, was as follows: Cl<sup>-</sup> 37.46%; SO<sub>4</sub><sup>2-</sup> 13.41%; and CO<sub>3</sub><sup>2-</sup> 9.45%. The water contained 62.36% NaCl, 19.72% Na<sub>2</sub>SO<sub>4</sub>, and 13.25% Na<sub>2</sub>CO<sub>3</sub>. Natural salts are collected during the dry season between May and September by a primitive method. Earthy salt collected in 1935 contained 46.01% NaCl, 16.31% Na<sub>2</sub>SO<sub>4</sub>, 12.34% Na<sub>2</sub>CO<sub>3</sub>, and 0.45% NaHCO<sub>3</sub>. Production of the earthy salt worked by nineteen men amounted 25,000 kg in 1935.</p> <p>(2) Natural soda: Borukku-nöru chiefly produces Na<sub>2</sub>CO<sub>3</sub>, Na<sub>2</sub>SO<sub>4</sub>, and NaHCO<sub>3</sub>. The chemical analysis of bottom deposits showed the following composition in percentage. Dark gray sandy silt on western coast: Na<sub>2</sub>CO<sub>3</sub>, 0.68; NaHCO<sub>3</sub>, 0.68; NaCl, 0.84; Na<sub>2</sub>SO<sub>4</sub>, 0.17. Light gray sand on northeastern coast: NaHCO<sub>3</sub>, 0.13; NaCl, 0.05; Na<sub>2</sub>SO<sub>4</sub>, 0.03. Light gray sand on southwestern coast: Na<sub>2</sub>CO<sub>3</sub>, 0.24; NaHCO<sub>3</sub>, 0.34; NaCl, 0.37; Na<sub>2</sub>SO<sub>4</sub>, 0.30. The whitish water of the lake, salinity 7.11% and water temperature 27° C as of July 7, 1935, was analyzed, with the following results: Cl<sup>-</sup> 23.96%; SO<sub>4</sub><sup>2-</sup> 12.86%; CO<sub>3</sub><sup>2-</sup> 17.62%; HCO<sub>3</sub><sup>-</sup> 7.61%; NaCl, 39.74%; Na<sub>2</sub>SO<sub>4</sub>, 18.92%; and Na<sub>2</sub>CO<sub>3</sub>, 29.42%.</p> <p>Natural soda accumulated on the lake bottom is estimated at 10 to 25 cm thick, and is collected through holes in the ice when the lake is frozen between November and February, because sodium carbonate becomes less soluble and crystallizes as the temperature falls. As the solubility of natural salt does not vary with temperature, the earthy soda gathered in winter does not contain NaCl. The earthy soda contains 26.61% Na<sub>2</sub>SO<sub>4</sub>, 66.50% Na<sub>2</sub>CO<sub>3</sub>, and 27.06% NaHCO<sub>3</sub>, although the lake water contains much NaCl and Na<sub>2</sub>SO<sub>4</sub>. About 500 kg of earthy soda is refined into 300 kg soda. Production of the earthy soda in 1931 amounted to 60,000 kg.</p>	<p>The map area is situated in the so-called Hilmunberh-Gobi desert, nothing is more important than water. Ground water is found at 2 to 3 m below the ground surface near lakes or rivers, and at 20 to 30 m in the steppes of the desert. A well at Man-chu-erh-miao gathers water from the first aquifer at a depth of 2 m and the second aquifer at 20 m. Location and known depths of wells are as follows. 1) In the western desert region: salt-refinery at Yen Hu (1.43 m); dune south of Bagasharaso-ko (2.1 m); 330 m east of the Yen-hu refinery (2.25 m); at Talgan-shihle (1 m) 8 km southwest of To-lu-han Hu; northern foot of a dune near To-lu-han Hu (2.35 m); 230 m north of Borukku-nöru (2.4 m). 2) Along the Rui Ho: 7 km southwest of Ta-li-wang-chia (4.8 m), Ta-li-wang-chia (5.5 m). 3) Along the I-min Ho: Mongolian camp 7 km northwest of Wei-shan (2.5 m); Toundan-beshi (1 m); fresh-water springs are also found in the fissures of the Paleozoic clay slate and limestone on the bank opposite Pirito.</p> <p style="text-align: center;">REFERENCES</p> <p>HARAGUCHI, Kuman, and others, 1937, Geology and geography of northwestern Manchuria: Geol. Inst., S. Manchuria Ry. Co.</p> <p>HATCHER, Torao, 1926, Geology and mineral resources along the route Tao-man -- Cha-lai-no-erh -- Man-chou-li: Unpub. rept., Geol. Inst., S. Manchuria Ry. Co.</p> <p>KAWADA, Michio, 1937, On the Pain Nor and other saline lakes, North Heining Province: Geol. Inst., S. Manchuria Ry. Co., Bull. no. 90.</p> <p>SAITO, Rinji, compiler, 1940, Geological map of Manchuria and adjacent areas, scale 1:3,000,000: Manchukuo Geol. Inst.</p>
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Koroto-nöru (Gozoro Nor)	43 NE	3.500	0.400	--	0.03	---	"																																																																																																																																																						
TERTIARY	Neogene basalt	 Olivine-augite basalt; thickness about 50 m	Neogene basalt is distributed in patches on the east side of the Rui Ho. The rock is a black or dark gray massive, cryptocrystalline, trap type basalt, rarely containing olivine and augite phenocrysts.																																																																																																																																																										
	Paleogene formation (Hserhna formation)	 Clay, sandstone and conglomerate; thickness more than 30 m	The Paleogene formation, or Hserhna formation [赫爾納組] according to Japanese geologists, crops out in the cliff on the north bank of the Ha-erh-ha Ho, where it extends horizontally for a distance of 20 km. The formation is divided into the upper, the middle and the lower beds, although the age of the upper bed has not been confirmed as Paleogene. The rocks constituting the formation are carbonaceous. The upper bed, 10 to 15 m thick, is chiefly white clay, and unconformably rests on the middle bed. The middle bed is 0.3-2 m thick, consists of dark gray sandstone and conglomerate, and thins out northward. The sandstone yields fossils of silicified wood, and bivalves in acid. The lower bed is 15 m thick and consists of grayish white porous sandstone and conglomerate. The bed is intercalated with a 30 cm thick alternation of white clay, sand and gravel. The gravel contains agate pebbles, 1 to 2 cm in diameter, and calcareous nodules 10 cm in diameter. The formation may be correlated with the Baron-Sog formation of Mongolia which is assigned to the Upper or Middle Oligocene age.																																																																																																																																																										
	Cretaceous andesite	 Biotite andesite	Cretaceous biotite andesite is exposed in the vicinity of Wei Shan [魏山]. It also occurs on the western bank of To-lu-han Hu where the rock is reddish brown due to weathering.																																																																																																																																																										
	Cretaceous rhyolite	 Rhyolite and cryptocrystalline rhyolite	The Cretaceous rhyolite occurs as flows, and is exposed in the eastern part of the map area. It consists of assemblage of rhyolite proper and cryptocrystalline rhyolite. The rock exposed on a hill 8 km east of Chagantoroqi-obo along the Rui Ho is composed of a rhyolite flow associated with obsidian and peraltesone.																																																																																																																																																										
	Lower Cretaceous formation	 Sandstone, conglomerate, graywacke and tuff; thickness unknown	The Lower Cretaceous formation is found in two places on the western bank of the I-min Ho. The formation in the northern place consists of light brown or grayish white sandstone and yellowish brown conglomerate containing pebbles of quartz porphyry. It strikes N 20° - 40° E and dips 20° - 30° SE. The formation in the south consists of an alternation of white tuffaceous conglomerate and white tuffaceous graywacke which yields fragments of plant fossils. It strikes N 18° E, and dips 28° NW. The formation exposed on the western bank of the K'uei-t'eng Ho [奎騰河] in the southeastern corner of the map area consists of white arkosic sandstone and tuff, and is intercalated with rhyolite flows. It strikes N 50° E and dips 24° NW.																																																																																																																																																										
MESOZOIC	Quartz porphyry	 Quartz porphyry	The quartz porphyry constituting a hill 25 km west-northwest of Ta-li-wang-chia [大井] is reddish brown or yellowish brown, consisting of phenocrysts of quartz and reddish orthoclase and holocrystalline groundmass, which rarely contains biotite phenocrysts and a few colored minerals. The rock is intruded by quartz veins which contain unworkable fluorite ore. The quartz porphyry may be a marginal facies of the Cretaceous granite.																																																																																																																																																										
	Cretaceous granite	 Porphyritic granite	The Cretaceous granite is exposed only in the hill of Chirebishi-Gra. The rock is a porphyritic granite.																																																																																																																																																										
	Jurassic formation	 Sandstone and shale; thickness unknown	The Jurassic formation is exposed along the small valley 5 to 10 km west of Hongoruji along the I-min Ho. It consists of an alternation of bluish white or reddish brown coarse-grained sandstone (each 1 m thick) and gray shale (each 2 m thick). It strikes N-S, dips 20° - 40° E or W, presenting repeated folds.																																																																																																																																																										
PALEOZOIC	Upper Paleozoic formation	 Slate, hornfels, limestone and shale; thickness unknown	The Upper Paleozoic formation, probably Carboniferous-Permian in age, is exposed on both sides of the middle reaches of the I-min Ho. The formation west of Hongoruji consists of an alternation of bluish gray clay slate and dark blue hornfels, each about 50 m thick. It strikes N 10° - 30° W, dips 40° - 70° W or E, and shows repeated folds. The formation south of Pirito consists of gray limestone in the upper part and gray shale in the lower part; the limestone, 70 m thick, yields crinoid fossil. The formation strikes N 10° - 20° E and dips 50° - 60° W, forming a monoclinical structure. The formation on the bank opposite Pirito consists of greenish black calcareous shale and grayish white limestone; the limestone is 200 m thick. The formation strikes N 30° E and dips 40° NW. A Paleozoic formation, probably Upper Paleozoic, is exposed in a hill 23 km south-southwest of Ta-li-wang-chia. It is composed of dark green hard slate, intruded by quartz porphyry dikes, and strikes N 20° E, dipping 30° SE.	<p><b>Limestone</b></p> <p>Limestone exposed on the hill south of Pirito, 90 km south of Hailar, was calcined for lime. Probable mineral reserves of the limestone are estimated at 150,000 tons, and the reserves of pure limestone excluding the sandy upper part, amount to 90,000 tons. Limestone on the bank opposite Pirito is 200 m thick and may be workable.</p>																																																																																																																																																									
	Metagneiss	 Injection gneiss	Metagneiss or green injection gneiss of unknown age is exposed on the top of a hill 15 km east of Chagantoroqi-obo along the Rui Ho. It consists of an alternation of greenish rock and white quartzitic rock, and exhibits a banded structure. Its schistosity strikes N 30° - 60° E.																																																																																																																																																										

(Column not drawn to scale)