GEOLOGIC LOG (4)

MJK - 1

INCLINATION: -90°

AREA: ZHAMAN-AIBAT BEARING: —

ELEVATION: 357.04m FINAL DEPTH: 650.50m

SCALE (m)	COLUMN	DEPTH (m)	DESCRIPTION		REMARKS	MINERALIZATION	SULFIDE	SILICA	CLAY	CARBONATE	SULFATE	SAMPLE No.	ROCK PROPERTY: Angle of Fiss. (°)	No. of Fiss. (/m)	Core Rec. %
		212.80	210.00-211.15m: Brown sandstone, fine-grained, with carbonate-ferrous cement. Bedding Structure at the angle 10°, 5° due to fine lamination, alternation with siltstone. The rock is medium fractured; fractures are filled in by gypsum and are oriented at 30°, 20°; their thickness varies from 1 mm to 2 cm. Contact with underlying horizon is clear, at the angle 0°.	∠5°~15°	Zhidelisol Formation (Gypsum-rich Red Siltstone)							∠5-10°	2	97
			211.15-212.80m: Red sandstone, fine-grained, with carbonate-ferrous cement. Bedding Structure (resulted from partings of dark-red fine-grained sandstone; thickness of partings is up to 1 cm) at the angle 15-10°. The rock is medium fractured; fractures are filled in by gypsum, oriented at 0°, 15°. Contact with underlying horizon is clear, wavy, at the angle 0°.	∠5°								〃	2	97
		219.05											〃	1	97
220			Brown siltstone, bedding structure (due to partings of greenish-gray siltstone with thickness up to 1 mm) at the angle 5°. The rock is medium fractured. Contact with underlying horizon is gradual.	∠5°									〃	2	97
		223.00		∠10°									〃	2	97
			219.05-219.55m: Brown colored fine-grained (muddy) sandstone with carbonate-ferrous cement. with graded bedding structure at the angle 5°. Contact with underlying horizon is sharp at the angle 5°.	∠5°~15°									〃	2	97
			219.55-223.00m: Brown siltstone with unclearly expressed bedded structure. Interlayers of dark-greenish-gray siltstone with thickness 13 cm and interlayers of red colored fine-grained sandstone with thickness 25 cm. The rock is medium fractured; fractures are filled in by gypsum, oriented at 5°. Contact with underlying horizon is clear, at the angle 10°.	∠10°								〃	1	97
		228.05											〃	1	97
230			223.00-226.20m: Red sandstone, fine-grained, with carbonate-ferrous cement. with the bedding structure (due to partings of red fine-grained sandstone) at the angle 15°, 5°. Interlayers of siltstone with thickness from 6 to 25 cm are observed. The rock is medium fractured; fractures are filled in by gypsum, fractures oriented at 10°, thickness of gypsum veinlets is up to 5 cm. Contact with underlying horizon is at <10°.	∠5°~15°									〃	1	97
			226.20-227.10m: Brown siltstone with unclearly expressed bedded structure. The rock is medium fractured. Contact with underlying horizon is clear, at the angle 0°.	∠5°									〃	1	97
			227.10-228.05m: Red sandstone, fine-grained, with carbonate-ferrous cement. Bedding structure due to partings of dark aleurolites is horizontal at the angle 5°. Interlayers of dark-red siltstone with thickness 10-15 cm are described there. Contact with underlying horizon is unclear and gradual.			238.10-238.40m: weakly silicified zone with gypsum veinlets							〃	1	97
240		242.30											〃	2	97
			Brown siltstone. Bedding structure (due to fine interlaying with fine-grained sandstone) is horizontal at the angle 5°. The rock is medium fractured; fractures are filled in by gypsum and oriented at 30°, 10°. Interlayer with calcite-gypsum-anhydrite aggregate with thickness 30 cm occurs at the depth 233.0 m; interlayer of fine-grained sandstone with thickness 35 cm described at 239.7 m. Contact with underlying horizon is gradual.	∠5°~15°								〃	2	97
														0	97
													〃	1	97
													∠10°	3	97
														0	97
														0	97
														0	97
250			242.30-242.75m: Light-brown colored, fine-grained sandstone with carbonate-ferrous cement. Bedding structure (due to partings of dark-brown siltstone with thickness 1mm) shows the angle 5-15°. Partings of dark brown colored siltstone with thickness up to 2 cm are observed as well. Contact with underlying horizon is clear, at 0°.	∠5°									∠20°	1	97
		252.40											∠5-10°	2	97
			242.75-252.40m: Brown siltstone. Unclearly expressed bedded structure. Interlayers of fine-grained sandstone with thickness 5-7 and 10-25 cm. The rock is medium fractured; fractures are filled in by gypsum (sienite), oriented at 5°, sometimes at 45°. Contact with underlying horizon is gradual.	∠0°~5°									〃	2	97
														0	97
													〃	1	97
													〃	2	97
														0	97
														0	97
														0	97
													∠5°	1	97
260			252.40-253.15m: Light-red colored fine-grained sandstone, with carbonate-ferrous cement. Bedding structure (due to fine interlaying with dark-red aleurolite, thickness of partings is up to 1 cm) is horizontal at the angle 5°. The rock is slightly fractured. Contact with underlying horizon is gradual.											0	97
														0	98
			253.15-258.00m: Brown siltstone with interlayers of fine-grained sandstone.	∠5°~15°	Zhidelisol Formation (Red Siltstone)									0	98
													∠5°	1	98
														1	98
			258.00-265.70m: Light-red colored, fine-grained sandstone with frequent interlayers of fine-grained sandstone (thickness is up to 20 cm). Bedding structure (due to partings of dark-red fine-grained sandstone) is horizontal at the angle 85°, lamination at the bottom of each layer at the angle 5-15°. Interlayer of brown siltstone(30 cm thick) is also observed. The rock is fractured; fractures are filled in by gypsum veinlets and films with thickness 5 mm. Contact with underlying horizon is gradual.										∠5-70°	3	98
		265.70												0	98
				∠15									∠75°	1	98
														0	98
														0	98
270		270.10		∠5°										0	98
		271.20	Light-red colored siltstone. Partings of fine-grained sandstone with thickness 3-5 cm are described through all the layer. The rock is slightly fractured; fractures contain films of gypsum.										∠20°	1	98
			Light-red colored fine-grained sandstone with bedding structure (due to changing granulometric composition) at the angle 15°. The rock is slightly fractured; fractures contain films of gypsum oriented at the angle 5°. Contact with underlying horizon is at 5°.	∠15°									∠10°	1	98
														0	98
														0	98
														0	98
														0	98
														0	98
														0	98
280			Brown, massive siltstone with unclearly bedded structure. Films of gypsum at fractures with thickness 1 mm, oriented at 55°, 45°. At the bottom of layer, the rock is strongly fractured (283.0-287.25 m). Contact is at 15°.											0	98

MJK - I

GEOLOGIC LOG (5)

AREA: ZHAMAN-AIBAT INCLINATION: -90° BEARING: —

ELEVATION: 357.04m FINAL DEPTH: 650.50m

REMARKS: Zhidelisol Formation (Red Siltstone)

DEPTH (m)	DESCRIPTION	Contact
287.40	Brown, massive siltstone with unclearly bedded structure. Films of gypsum at fractures with thickness 1 mm, oriented at 55°,45°. At the bottom of layer, the rock is strongly fractured (282.9-287.40 m). Contact is at 15°. Thin layers of green-dark green colored siltstone are observed within the interval from 286m to 287.20m	∠15°
291.40	Light-red colored, fine-grained sandstone, with carbonate-ferrous cement., cross-bedded at 5-15° due to partings of dark-red siltstone. Interlayers of dark-red siltstone with total thickness 0.6 m are observed as well. The rock is slightly fractured; fractures are filled in by gypsum. Contact with underlying horizon is at 0°.	∠5°-15°, ∠0°
316.60	Brown siltstone with unclearly bedded structure. Including the interlayers of fine-grained sandstone with thickness up to 30 cm, maximum thickness reaching 0.8 m. These rocks are fractured; fractures are filled in by gypsum (up to 1 mm thick). Contact with underlying horizon is at 0°. Thin layers of green-dark green colored siltstone are observed within the interval from 312.90m to 313.10m	∠0°
318.70	Red colored fine-grained sandstone with carbonate-ferrous cement.. Structure is horizontally-bedded at the angle 5° due to partings of dark-red siltstone; thickness of partings reaching 1 cm. Contact with underlying horizon is at 0°.	∠5°, ∠0°
320.20	Light green colored siltstone	
323.90	Red, massive siltstone with unclearly bedded structure. Including interlayers of fine-grained sandstone. Contact with underlying horizon is gradual.	
329.90	Alternation of dark-red siltstone and fine-grained sandstone. Siltstone layers are dominant.. Fine-grained sandstone layers occur at the intervals 324.0-324.4, 325.3-325.55, 328.1-328.4, 329.3-329.6 m. Structure is horizontally-bedded at the angle 5°. Fractures are filled in by gypsum films.	∠5°
332.40	Alternation of dark-red siltstone and fine-grained sandstone. Sandstone layers are dominant. Sandstone layers are light-red colored, and matrix is composed of carbonate-ferrous cement.. Bedding structure (due to interlaying with siltstone) is horizontally-bedded at the angle 5°. Stretched-shaped fragments of red aleurolite 0.3 x 1.0 cm in size occur at the bottom of the Sandstone layer. Contact with underlying horizon is clear at 15° as to core axis.	∠5°, ∠15°, ∠10°-15°
	Brown, sandy siltstone with frequent interlayers of fine-grained sandstone. with thickness 10-15 cm with lamination at 15-10°. The rock is medium fractured; fractures are filled in by gypsum, its thickness varying from fiber-like to 1 mm; they are oriented at 5-15°. Contact with underlying horizon is gradual.	
349.30	Light-red colored fine-grained sandstone with carbonate-ferrous cement. Sedimentary structure (due to partings of dark-red, fine-grained siltstone) is cross-bedded at 65°, 0°, 10°. The rock is slightly fractured. Interlayers of dark-red sandstone are also described there. Contact with underlying horizon is clear at 0°.	∠0°

SCALE (m): 290, 300, 310, 320, 330, 340, 350

MINERALIZATION: SULFIDE, SILICA, CLAY, CARBONATE, SULFATE

SAMPLE No.

ROCK PROPERTY

Angle of Fiss. (°)	No. of Fiss. (/m)	Core Rec. %
	0	98
	0	98
∠20°	3	98
∠30°	4	98
∠10°	10	98
"	10	98
∠10-45°	10	98
	0	98
∠10-40°	2	98
∠10°	2	98
	0	98
∠10-45°	2	98
∠10°	1	98
	0	98
	0	98
	0	98
	0	98
	0	98
∠10°	1	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
∠20°	1	98
	0	98
∠5°	2	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
	0	98
∠10°	1	98
	0	98
	0	98
	0	98
	0	98
∠25°	1	98
	0	98
∠5°	1	98
	0	98
	0	98
	0	98
∠10°	1	98
	0	98
	0	98
∠20°	1	98
	0	97
	0	97
	0	97
∠5°	1	97
	0	97
	0	97
	0	97

GEOLOGIC LOG (6)

MJK - 1

INCLINATION: -90°

AREA: ZHAMAN-AIBAT BEARING: — ELEVATION: 357.04m FINAL DEPTH: 650.50m

SCALE (m)	DEPTH (m)	DESCRIPTION	REMARKS	MINERALIZATION	SULFIDE	SILICA	CLAY	CARBONATE	SULFATE	SAMPLE No.	ROCK PROPERTY: Angle of Fiss. (°)	No. of Fiss. (/m)	Core Rec. %
		Dark-reddish brown, sandy siltstone with potted / bedded structure due to interlaying with fine-grained sandstone. Interlayers of fine-grained sandstone show cross-bedded structure (thickness 15-25 cm). The rock is slightly fractured, fractures contain gypsum with thickness 5 mm.										2	97
	356.45	Reddish brown, sandstone, medium-grained, sometimes coarse-grained, with carbonate-ferrous cement.. Graded bedding structure and cross-bedding structure are observed (at the angle 10-20°, 5°). Frequent accumulations of anhydrite / gypsum sizing up to 1.0 x 0.8 cm are described within the interval from 356.65 to 356.95 m. Fragments of red siltstone are described at the bottom of the layer with size up to 0.2 x 0.5 m. Contact with underlying horizon is clear at 5°. Gypsum interlayer (1 cm thick) is occurred at the contact.	∠5° ~20°									0	97
	358.70		∠5°									0	97
360											∠20°	1	97
											∠10°	2	97
											"	1	97
												0	97
												0	97
												0	97
												0	97
												0	97
	365.50	Dark-gray, sandy siltstone with potted and lenticular-bedded structure due to interlayers and spots of light fine-grained limy sandstone. Interlayers of fine-grained sandstone with thickness 18 cm are also observed. Contact with underlying horizon is gradual.										0	97
		Reddish brown, fine-grained sandstone with carbonate-ferrous cement. Structure is horizontally-bedded, sometimes cross-bedded at the angle 10-15° due to partings of fine-grained sandstone with darker shading with thickness of the partings equal to 0.1 mm. Partings of dark-red siltstone with thickness up to 3 cm. Accumulations of anhydrite (1.0 x 1.5 cm) are also observed there. The rock is slightly fractured; fractures are coated by gypsum film. Contact with underlying horizon is at 0°. Interlayer of intraformational conglomerate (8 cm thick) at the contact.									∠20°	1	97
370	369.95		∠0°									0	97
			∠5° ~10°									0	97
												0	97
												0	97
												0	97
												0	97
												0	97
												0	97
												0	97
												0	97
												0	97
		Red, sandy siltstone, horizontal-bedding, including interlayers of limy fine-grained sandstone with thickness up to 10 cm. The rock is fractured. Contact with underlying horizon is at the angle 5°. 371.6-372.1m: Red, fine-grained sandstone with carbonate-ferrous cement including interlayers of siltstone. Cross-bedded structure at the angle 5-10°.										0	97
	379.70		∠5°									0	97
380												0	97
												0	97
											∠10°	1	97
												0	97
			∠10° ~15°									0	97
												0	97
												0	97
		Sandstone layers: Reddish brown, fine-medium grained sandstone, with carbonate-ferrous cement., fine interlaying with fine-grained sandstone (0.2cm thick) , cross-bedded at the angle 15-10°. The rock is slightly fractured, filled in by gypsum films. Contact with underlying horizon is wavy. 397.15-397.85m: Grayish-red, fine-grained laminated sandstone with siliceous-carbonate-ferrous cement. **Siltstone layers:** Reddish brown, sandy siltstone or aleurosandstone, including interlayers of light limy fine-grained sandstone with thickness 3-5 cm , horizontally-bedded . Contact with underlying horizon is sharp at the angle 0°.										0	97
390												0	97
											∠10°	1	97
												0	97
												0	97
												0	97
												0	97
	397.85		∠0°	397.15-397.85m: Weakly silicified								0	97
											∠35°	4	97
											"	1	97
400		Reddish brown, sandy siltstone including spots of light-red limy sandstone and rare spots of green aleurolite. Interlayer of greenish-gray fine-grained sandstone with thickness 25 cm occur at the depth 403.2 m; Thin interlayers of gray colored fine-grained sandstone with thickness 20 cm are observed at the interval from 413 to 419m. Contact with underlying horizon is gradual.										0	97
												0	97
				403.20m: Appearance of gray sandstone								0	97
												0	97
												0	97
												0	97
												0	97
												0	97
												0	97
410		Reddish-gray, fine-grained sandstone with siliceous-carbonate-ferrous cement, horizontally-bedded at 5°. Sometimes transforming into medium-coarse-grained sandstone. Partings of greenish-gray aleurolite with thickness 3-5 cm, interlayer of red aleurolite with thickness 20 cm are observed as well. Fragments of dark-red aleurolites. Contact is with underlying horizon is gradual.										0	97
												0	97
												0	97
												0	97
												0	97
	415.75	Reddish brown, sandy siltstone, spotted-bedded structure due to interlaying with fine-grained sandstone. Contact with underlying horizon is unclearly expressed, oriented at the angle 0° .		415.75-417.60m: Weakly disseminated by pyrite Weakly silicified								0	97
	417.60		∠5°									0	97
				419.80m-420.80m: Weakly disseminated by pyrite Pyrite grains are very fine								0	97
420			∠0°								∠10°	3	97
												0	97

Zhezkazgan Formation (Gray Sandstone)

Zhideli Formation (Red Siltstone)

Zhideli Soil

GEOLOGIC LOG (7)

MJK - 1

INCLINATION: -90°

AREA: ZHAMAN-AIBAT BEARING: — ELEVATION: 357.04m FINAL DEPTH: 650.50m

SCALE(m)	DEPTH (m)	DESCRIPTION	REMARKS	MINERALIZATION	SULFIDE	SILICA	CLAY	CARBONATE	SULFATE	SAMPLE No.	ROCK PROPERTY: Angle of Fiss. (°)	No. of Fiss. (/m)	Core Rec. %
		Reddish brown, sandy siltstone, massive with lamination due to interlaying with gray fine-grained sandstone. Interlayer of reddish-gray fine-grained sandstone occurs at the interval 421.3-421.75. Contact with underlying horizon is clear at the angle 5°.										0	97
												0	97
												0	97
												0	97
												0	97
	426.65	Gray medium-fine-grained sandstone with siliceous-carbonate-ferrous cement.. Interlayer of gray aleurolite with thickness 10 cm, fragments of dark-gray aleurolite 0.5 x 1.0 cm are observed as well. Contact with underlying horizon is clear at the angle 0°.	∠5°	426.65-428.40m: Pyrite accumulations with size up to 0.4-0.8 cm, and weakly disseminated by pyrite through the layer. Weak silicification								0	97
	428.40		∠0°									0	97
	430.00	Reddish brown siltstone with gray spots. with interlayers of fine-grained sandstone with thickness 20 cm. Bedding structure is horizontal. Contact with underlying layer is gradual.	∠0°									0	97
430				430.00-432.25m: Calcite films								0	97
	432.25	Gray sandstone with red spots, fine-grained, with siliceous-carbonate cement.. Bedding structure is horizontal, cross-bedded at the angle 5-10° The rock is slightly fractured, with films of calcite at fractures. Contact with underlying layer is unclear at the angle 0°.	∠0° ~10°									0	97
												0	97
										435.0m ~435.3m	∠80°	1	97
										44		0	97
												0	97
	438.80	Reddish brown, sandy siltstone, including "sandstone balls(2-4cm)" and thin layers of sandstone. Interlayer of grayish-red fine-grained sandstone with thickness 16 cm occurs at the depth 437.55 m. Contact with underlying layer shows load casting structure(wavy).										0	97
											∠45°	1	97
440	440.70		∠5°	438.80-440.70m: Weakly disseminated by pyrite.						440.0m ~440.3m		0	97
										45		0	97
		Dark greenish gray, sandy siltstone, horizontally-bedded at the angle 5°. With lamination structure due to interlayers of sandstone. Contact with underlying layer is gradual.									∠40°	1	97
				440.7-442.0m, 442.4-443.2m: Disseminated by pyrite Weak silicification								0	97
	444.40		∠5° ~10°									0	97
		Light-gray, coarse- fine-grained sandstone with siliceous-carbonate cement, with calcite films coating fractures .. Graded bedding structure is developed at the angles 5°, 10°. Contact with underlying layer is gradual. Frequent very fine grained pyrite crystals occurring at the rock mass.										0	97
										445.0m ~445.3m		0	98
	445.50									46		0	98
		Reddish brown, sandy siltstone.		445.50-451.90m: Disseminated by pyrite								0	98
				446.5-447.7m: weak								0	98
				447.7-448.2m: strong								0	98
450		445.50-449.00m: Dark-gray, laminated medium-grained sandstone with siliceous-carbonate cement., with siltstone thin layers. There are a lot of fragments of greenish-gray aleurolite with size up to 3 x 5 cm. Frequent small pyrite crystals occur in the rock mass.		448.2-451.9m: weak						450.0m ~450.3m		0	98
	451.90		∠0°							47		0	98
		449.00-451.90m: Black-dark gray, siltstone with the bedding structure due to the fine lamination of fine-grained sandstone layers. Joints are oriented at the angle 15-20, 80°. Contact with underlying layer is at the angle 0°. Frequent small pyrite crystals described in the rock mass.										0	97
				451.90-454.60m: Weakly disseminated by pyrite.								0	97
	454.60	Gray, medium grained sandstone with siliceous-carbonate cement., with partings of dark-gray aleurolite with thickness 1-3 cm, and with fragments of dark-gray aleurolite sizing from 0.5 x 1.5 cm to 3 x 4 cm.										0	97
										455.0m ~455.3m		0	97
										48		0	97
												0	97
												0	97
											∠10-60°	2	97
460		Dark gray-black, sandy siltstone, with the bedding structure at the angle 5° due to partings of fine-grained sandstone. Joints are coated with calcite films; joints are oriented at the angle 5°, sometimes at the angle 45°. Contact with underlying layer is gradual. 459.10-460.45m: Light-gray, fine-grained sandstone with siliceous-carbonate cement..	∠5°	454.60-464.80m: Weakly disseminated by pyrite 459.0-459.6m: Medium-strongly						460.0m ~460.3m	∠40°	1	97
										49		0	97
												0	97
												0	97
	464.80											0	97
										465.0m ~465.3m		0	97
				464.80-474.80m: Weakly disseminated by pyrite 473.7-475.0m: Strongly disseminated by pyrite.						50		0	97
		Gray-Light gray, coarse-medium grained laminated sandstone, with siliceous-carbonate cement., horizontally bedded, including a lot of thin interlayers of black siltstone with thickness up to 1 mm. The rock is slightly fractured with calcite films coating joints. Interlayer of greenish-gray aleurolite occurs in the interval 470.7-470-85. The rock is slightly fractured. Contact with underlying layer is at the angle 10°.	∠0°									0	97
												0	97
470										470.0m ~470.3m		0	97
										51		0	97
											∠10-70°	3	97
												0	97
												0	97
	474.80		∠10°									0	97
										475.0m ~475.3m		0	97
										52		0	97
		Greenish gray-dark gray, siltstone, including lenses of gray fine-grained sandstone. Joints oriented at the angle 60-55°, calcite films coating joints. Contact with underlying layer is gradual.		474.8-480m: Weak Chloritizatin 480-483.7m: Disseminated by pyrite								0	99
												0	99
												0	97
480										480.0m ~480.3m		0	97
										53		0	97
												0	97
											∠70°	1	97
	483.80											0	97
										485.0m ~485.3m		0	97
		Brown, Alternation beds of Bituminous sandstone(with siliceous-carbonate cement) and siltstone. Interlayer of greenish-gray colored fine-grained sandstone occurs in the interval 484.15-484.3m. A lot of oil saturation zones are described in the interval 484.0-491.0m.	∠0°	484.0-491.0m: Appear Bituminous sandstone 487.4-489.0m: weakly disseminated by pyrite						54		0	97
												0	97
												0	97
												0	97
490												0	97

Zhezkazgan Formation (Gray Sandstone)

GEOLOGIC LOG (8)

MJK - 1

INCLINATION: -90°

AREA: ZHAMAN-AIBAT BEARING: — ELEVATION: 357.04 m FINAL DEPTH: 650.50 m

SCALE (m)	DEPTH (m)	DESCRIPTION	REMARKS	MINERALIZATION	SULFIDE	SILICA	CLAY	CARBONATE	SULFATE	SAMPLE No.	ROCK PROPERTY: Angle of Fiss. (°)	ROCK PROPERTY: No. of Fiss. (/m)	ROCK PROPERTY: Core Rec. %
	491.90	Gray, fine-grained sandstone with siliceous-carbonate cement. Accumulation of pyrite crystals observed at the interval 490.35-490.4m. Oil saturation in the interval 490.2-490.9m. The rock is slightly fractured; calcite films at fractures. Contact with underlying layer is at the angle 5°.	∠5°	490.2-490.9m: Appear Bituminous sandstone						55 490.0m ~ 490.3m		0	97
	493.20			493.20-495.10m: Disseminated by pyrite								0	97
	495.10	Dark-gray, siltstone with laminated and thinly bedded sandstone.	∠15°							495.0m ~ 495.3m		0	97
		Gray, fine-grained sandstone with siliceous-carbonate cement., cross-bedded at the angles 15. Spots with increased pyrite content are also described through the layer, with calcite films coating joints, joints.								56		0	97
				495.10-499.45m: Weak Chloritization Very weak pyrite dissemination							∠70°	1	97
	499.45											0	97
500		Dark-gray, siltstone, with thinly bedded sandstone, at the angle 5°, including spots of light-gray limy sandstone. Joints contain calcite films. Contact with underlying layer is gradual.	∠5°							500.0m ~ 500.3m		0	97
	502.90		∠0°	499.45-502.90m: Weakly disseminated by pyrite Veinlets of calcite						57		0	97
		Gray fine-grained sandstone with siliceous-carbonate cement., with thinly and horizontally bedded siltstone. Interlayer of intraformational conglomerate is observed within the interval 500.8-500.86. Calcite films coating joints and Veinlets of calcite 4 cm thick is observed at the bottom of the layer.		502.9-505.0m: Weakly disseminated by pyrite 502.9-506.1m: Weak Chloritization 505.0-505.3m: Cu, mineralization, Cu 12%, Ag 72.9 g/t						506.0m ~ 506.3m 58		0	97
	509.40	Greenish-gray-Dark-gray, fine-grained sandstone with siliceous-carbonate cement with horizontally and thinly bedded aleurosandstone. The rock is slightly fractured with calcite films coating joints. Contact with underlying layer is 0°.	∠0°							510.0m ~ 510.3m 59		0	97
510												0	97
		Greenish-gray - dark gray, sandy siltstone. Structure is bedded at the angle 0-5° due to fine lamination with dark-gray sandstone. Contact with underlying layer is gradual. Rare concretions of pyrite with size 1 x 1 - 1.5 - 2.0 cm are described through the layer.	∠0° 5°							515.0m ~ 515.3m 60		0	97
				515.6-516.2m, 519.3-525.0m; Weakly disseminated by pyrite								0	97
520										520.0m ~ 520.3m 61		0	97
	521.70	Gray-greenish gray, fine-medium grained sandstone with thinly and horizontally bedded red-green colored shade with siliceous-carbonate cement. Concretions of pyrite are observed within the layer. The rock is medium fractured with calcite films coating joints.	∠0°									0	97
	524.60			521.70-524.60m: Disseminated by pyrite								0	97
		Gray, sandy siltstone. Interlayer of horizontal micro-crystalline limestone is observed within the interval 535.5-535.9 m and 528.2-528.4m. Frequent concretions of calcite sizing from 0.1 x 0.2 cm to 0.5 x 1.0 cm are described within the interval 527.4--527.8m and 531.7-534.8 m. Contact with underlying layer is at the angle 0°.								525.0m ~ 525.3m 62		0	97
530				527.4-534.8m: concretions of calcite						530.0m ~ 530.3m 63		0	97
	535.45		∠0°							535.0m ~ 535.3m 64		0	97
		Dark gray-greenish gray, alternation beds of fine-grained sandstone and siltstone bedded at the angle 5° with calcite films and pyrite concretions at joints. Contact with underlying layer is at the angle 0°.		537.0-539.0m: Weakly disseminated by pyrite								0	97
540	540.75		∠0°							540.0m ~ 540.3m 65		0	97
		Pale gray-greenish gray, alternation beds of fine-grained sandstone (with siliceous cement and) siltstone bedded at the angle 0°. Lamination and graded bedding structure are developed. Weak pyrite dissemination is observed at the sandstone layers. Oil saturation in the interval 544.45-545.80m and 549.50-550.35m.		540.75-552.15m: Weak pyrite dissemination in the sandstone layers. 544.45-545.80m and 549.50-550.35m: Oil saturation						545.0m ~ 545.3m 66	∠5°	1	97
			∠0°									0	97
550										550.0m ~ 550.3m 67		0	97
	552.15											0	97
		Greenish-gray - dark gray, sandy siltstone. Structure is bedded at the angle 0-5° due to fine lamination with dark-gray sandstone. Contact with underlying layer is gradual. 556.8-557.15m: gray, medium grained sandstone with weak pyrite dissemination and with Oil saturation.	∠0° 5°	556.8-557.15m: weak pyrite dissemination and Oil saturation.						555.0m ~ 555.3m 68	∠10°	2	97
	559.00	Pale gray, Coarse-fine grained sandstone, with graded bedding and lamination structure, bedding structure at the angle 10°.	∠10°	559.00-560.00m: Weak pyrite dissemination								0	97
560													

Zhezkazgan Formation (Gray Sandstone)

GEOLOGIC LOG (9)

MJK - 1

INCLINATION : -90°

AREA : ZHAMAN-AIBAT BEARING : — ELEVATION : 357.04m FINAL DEPTH : 650.50m

SCALE(m)	DEPTH (m)	DESCRIPTION	REMARKS	MINERALIZATION	SULFIDE	SILICA	CLAY	CARBONATE	SULFATE	SAMPLE No.	ROCK PROPERTY: Angle of Fiss. (°)	No. of Fiss. (/m)	Core Rec. %
	561.70	Gray, coarse-fine grained sandstone, with siliceous cement. Graded bedding structure is developed at the angle 5°. Calcite films and fine abundant pyrite impregnation filling joint are observed through the layer.	∠5°	560.00-561.70m: pyrite dissemination(medium) and calcite films (weak)						69 560.0m ~ 560.3m		0	97
	568.00	Gray-pale greenish gray, fine alternation beds of sandy siltstone and fine grained sandstone, at the angle 5°-15°. Sometimes it contains sand-balls. Cristals and concretions of pyrite are observed at the interval from 564.6 to 565.0m. Contact with underlying layer is at the angle 0°.	∠5°~15° ∠0°	564.6-565.0m: Strongly disseminated by pyrite 565.0-568.0m: Weakly disseminated by pyrite						565.0m ~565.3m 70		0	97
570		Pale gray, coarse-fine grained sandstone with siliceous-carbonaceous cement, graded bedding structure is developed. Weak pyrite dissemination is observed all through the layer. Partially including brecciated siltstone fragments at the interval from 573.4 to 574.1m and from 576.0 to 577.9m. Bedding structure is horizontal, sometimes cross-bedded at the angle 5°-15°. Joints are oriented at the angle 5°-35°. Contact with underlying layer is wavy and gradual.	∠5°~15°	568.00-578.20m: Weak pyrite dissemination						570.0m ~570.3m 71		0	97
	578.20	Alternation beds of Sandstone and siltstone, horizontalliy bedded. 583.0-585.3m: Weak pyrite dissemination **Sandstone layers:** Coarse-medium-fine grained sandstone layers showing graded bedding structure with Weak oil odor, Thickness: 0.9m-1.2m. Abundant fragments of greenish gray siltstone are observed in the layer. Contact with underlying layer is wavy (load cast ?). **Siltstone layers: Greenish gray,** Rare carbonaceous concretions with size up to 1.0 x 1.5cm and black mud ball are observed in the layer.	∠0°							575.0m ~575.3m 72		0	97
580										580.0m ~580.3m 73		0	97
	585.30	Gray, fine garined laminated sandstone, horizontally bedded. Dark gray colored interlayers with abundant pyrite are observed through the sandstone layer. Contact with underlying layer is at the angle 10°.		583.0-585.3m: Weak pyrite dissemination Sandstone layers: Weak oil odor						585.0m ~585.3m 74		0	97
		Gray-dark gray, laminated and thinly bedded sandstone including a small quantity of siltstone thin layers. Distinct graded bedding structure (bedding inclination; 0°-10°) is observed. Pyrite dissemination is observed all through the layers, strongly disseminated zones are distributed in the coarse grained sandstone layers.	∠0°	585.30-590.94m: Thin layers with pyrite concentration						Sample No. 1~43		0	97
590	590.94		∠10°							(591.0m ~610.0m)		0	97
		Dark gray, alternating beds of fine grained sandstone(arenite) and siltstone, bedded at the angle 0°-5°. Chalcocite concentrated thin layers and weak pyrite dissemination (including a small amount of galena-chalcopyrite-bornite) are observed at the sandstone layers.	∠0°~10°	590.94-597.60m: Pyrite dissemination 590.94-592.72m: strrong 592.72-593.95m: weak 594.35-594.64m: strrong 594.64-595.80m: weak 595.80-597.60m: strrong						1		0	97
	597.60	Light gray-brown, medium graind massive sandstone, containing a small amount of conglomerate and siltstone thin layers, bedded at the angle 3°-7°. Dissemination by chalcocite (>>galena,bornite,chalcopyrite>pyrite) are observed within the interval 599.0-605.78m.	∠0°~5°	599.00-600.12m: Chalcocite concentration layers and weak pyrite dissemination						5		0	97
600	600.12									10	∠15° ∠5°	2	97
		Brownish light gray-greenish light gray, intraformational conglomerate (RAIMUNDO Conglomerate), consisting of angular fragments of white or pink-colored limestone and siltstone (sizing from 5 x 5mm to 15 x 30mm) and cement of green colored (caused by weak chloritization) muddy sandstone. At the bottom of the layer, cement is represented by red sandstone. No mineralization observed.	∠3°~7°	600.12-605.78m:Dissemination by chalcocite(>>galena,bornite, chalcopyrite >pyrite) 600.12-605.78m: strong 605.78-607.98m: very weak						15	∠5°	1	97
	608.27	Gray (partially brown), fine-medium grained sandstone(arenite) with siliceous-carbonaceous cement with horizontal graded bedding structure. Contact with underlying layer is wavy. Very weak pyrite dissemination is observed.	∠0°	609.30-610.75m: Very weak pyrite dissemination						20		0	97
	609.30									25		0	97
610	610.75									30	∠10°	1	97
		Reddish brown, siltstone with indistinct bedded structure. Calcite concretions with size 0.3 x 0.6cm and no mineralization observed.								35		0	97
	614.35										∠10°	2	97
		Reddish light brown, laminated fine-medium grained sandstone, bedded at the angle 5°-10°. Reddish brown colored shale layer is observed within the interval 617.20-618.30m. Contact with underlying layer is wavy.	∠5°~10°	614.35-621.40m: Very weak pyrite dissemination						40		0	97
620	621.40									43		1	97
		Reddish brown, horizontally bedded siltstone, containing calcite concretions sizing from 0.3 x 0.5cm to 0.5 x 2.0cm. Brown colored laminated sandstone layer is observed within the interval 624.65-625.80m and 628.00-630.00m.	∠0°								∠5°	2	97
												0	97
												0	97
											∠10°	1	97
												0	97
												0	97
										621.0m ~621.3m 75		0	97
												0	97
												0	97
												0	97
												0	97
												0	97
												0	97
												0	97
630												0	97

REMARKS: Zhezkazgan Formation (Gray Sandstone) | Weakly Mineralized Zone | Cu - Mineralized | Weakly Mineralized | Taskuduk Formation

GEOLOGIC LOG (10)

MJK - 1

INCLINATION : -90°

AREA : ZHAMAN-AIBAT BEARING : — ELEVATION : 357.04m FINAL DEPTH : 650.50m

SCALE (m)	COLUMN	DEPTH (m)	DESCRIPTION	REMARKS	MINERALIZATION	SULFIDE	SILICA	CLAY	CARBONATE	SULFATE	SAMPLE No.	ROCK PROPERTY: Angle of Fiss. (°)	ROCK PROPERTY: No. of Fiss. (/m)	ROCK PROPERTY: Core Rec. %
			Reddish brown, siltstone with indistinct horizontal bedded structute, containing calcite concretions sizing from 0.5 x 1cm to 2 x 3cm. Interlayers of medium grained sandstone and intraformational conglomerate are observed at the middle of the layer. ∠ 0°	Taskuduk Formation								0	97
												∠ 10°	2	97
													0	97
													0	97
													0	97
													0	97
													0	97
													0	97
													0	97
		639.80											0	97
640			Brownish gray, laminated medium grained sandstone, strongly fractured at the top of the layer. Contact with underlying layer is wavy.								642.0m ~ 642.3m 76		0	97
			Intraformational pebble conglomerate, consisting of red colored siltstone fragments and medium grained sandstone matrix. Contact with underlying layer is wavy. ∠ 5°										0	97
													0	97
													0	97
													0	97
													0	97
		646.90											0	97
		647.80	Red colored siltstone with indistinct bedded structure. Calcite concretions 0.5 x 1cm in size occur at the top of the layer. Interlayer of fine grained sandstone is observed within the interval 648.80-649.20m.										0	97
													0	97
650		650.50											0	97
		(Final Depth)												

Appendix 7 Assay Results of core Samples from Drill Hole "MJK-1"

Sample No.	From m	To m	Length m	Au ppb	Ag g/t	Cu %	Pb %	Zn %	Fe tot %	Re ppm	S sulfide %	S sulfate %	S tot %	S elem %	FeO %
No.01	591.00	591.50	0.50	< 5	0.3	0.01	0.05	0.02	2.36	3	0.87	0.02	0.89	< 0.01	1.50
No.02	591.50	592.00	0.50	< 5	1.0	0.01	0.01	0.01	1.81	< 1	0.77	0.01	0.78	.....	.....
No.03	592.00	592.50	0.50	< 5	0.3	0.02	0.04	0.01	1.98	3	1.04	0.01	1.05	.....	.....
No.04	592.50	593.00	0.50	< 5	0.7	0.06	0.07	0.02	2.16	< 1	0.73	0.01	0.74	.....	.....
No.05	593.00	593.50	0.50	< 5	0.3	0.03	0.03	0.03	2.16	< 1	0.72	0.02	0.74	.....	.....
No.06	593.50	594.00	0.50	< 5	0.3	0.07	0.10	0.02	1.48	6	0.47	0.01	0.48	.....	.....
No.07	594.00	594.50	0.50	< 5	0.7	0.09	0.01	0.02	1.54	4	0.45	0.01	0.46	.....	.....
No.08	594.50	595.00	0.50	< 5	0.3	0.09	0.01	0.04	2.38	< 1	0.58	0.01	0.59	.....	.....
No.09	595.00	595.50	0.50	< 5	0.7	0.16	0.02	0.09	1.79	< 1	0.48	0.01	0.49	.....	.....
No.10	595.50	596.00	0.50	< 5	1.0	0.11	0.04	0.05	1.36	< 1	0.67	0.01	0.68	.....	.....
No.11	596.00	596.50	0.50	< 5	0.3	0.06	0.03	0.03	2.24	< 1	0.64	0.00	0.64	.....	.....
No.12	596.50	597.00	0.50	< 5	0.7	0.16	0.01	0.03	2.30	< 1	0.84	0.01	0.85	.....	.....
No.13	597.00	597.50	0.50	< 5	0.3	0.04	0.02	0.02	2.92	< 1	0.53	0.01	0.54	.....	.....
No.14	597.50	598.00	0.50	< 5	0.3	0.04	0.07	0.05	3.00	3	1.40	0.01	1.41	.....	.....
No.15	598.00	598.48	0.48	< 5	1.4	0.53	0.11	0.22	3.61	4	1.70	0.01	1.71	0.05	3.13
No.16	598.48	599.03	0.55	< 5	1.0	0.32	0.02	0.22	2.34	6	0.85	0.01	0.86	.....	.....
No.17	599.03	599.21	0.18	< 5	6.9	2.02	0.03	0.02	2.97	1	1.34	0.02	1.36	.....	.....
No.18	599.21	599.82	0.61	< 5	6.9	1.18	0.08	0.02	3.25	1	1.34	0.01	1.35	.....	.....
No.19	599.82	600.02	0.20	< 5	37.4	14.50	1.82	0.02	3.30	9	4.76	0.02	4.78	.....	.....
No.20	600.02	600.40	0.38	< 5	3.4	0.51	3.27	0.01	2.68	11	0.63	0.06	0.69	.....	.....
No.21	600.40	600.77	0.37	< 5	7.9	1.54	1.04	0.01	1.34	11	0.58	0.04	0.62	.....	.....
No.22	600.77	601.75	0.98	< 5	10.6	1.34	6.54	< 0.01	1.34	34	1.33	0.05	1.38	.....	.....
No.23	601.75	602.17	0.42	< 5	86.7	12.00	0.08	0.01	1.00	40	3.03	0.01	3.04	.....	.....
No.24	602.17	602.68	0.51	< 5	26.4	4.99	0.26	< 0.01	1.55	14	1.32	0.02	1.34	.....	.....
No.25	602.68	603.10	0.42	< 5	118.6	15.30	0.21	< 0.01	0.99	20	4.04	0.03	4.07	0.02	14.80
No.26	603.10	603.66	0.56	< 5	11.3	1.96	< 0.01	< 0.01	1.28	4	0.51	0.11	0.62	.....	.....
No.27	603.66	604.05	0.39	< 5	10.3	2.22	0.74	< 0.01	1.30	5	0.71	0.07	0.78	.....	.....
No.28	604.05	604.15	0.10	40	6.9	1.34	< 0.01	0.01	2.46	2	0.39	0.01	0.40	.....	.....
No.29	604.15	604.65	0.50	< 5	14.4	2.35	< 0.01	< 0.01	1.35	< 1	0.61	0.07	0.68	.....	.....
No.30	604.65	605.00	0.35	< 5	27.8	4.59	< 0.01	0.01	0.80	< 1	1.18	0.31	1.49	.....	.....
No.31	605.00	605.20	0.20	< 5	23.7	3.50	< 0.01	< 0.01	1.43	< 1	0.91	0.11	1.02	.....	.....
No.32	605.20	605.34	0.14	< 5	38.7	10.30	< 0.01	< 0.01	2.35	4	2.55	0.06	2.61	.....	.....
No.33	605.34	605.47	0.13	< 5	16.1	2.62	0.03	< 0.01	2.35	< 1	0.73	0.03	0.76	.....	.....
No.34	605.47	605.61	0.14	< 5	12.0	1.88	< 0.01	0.01	1.81	2	0.53	0.04	0.57	.....	.....
No.35	605.61	605.78	0.17	< 5	39.8	7.51	< 0.01	< 0.01	1.48	< 1	1.92	0.04	1.96	0.04	6.99
No.36	605.78	606.50	0.72	< 5	0.3	0.03	< 0.01	0.01	1.67	< 1	0.01	0.12	0.13	.....	.....
No.37	606.50	607.00	0.50	< 5	0.3	0.02	< 0.01	0.01	2.01	< 1	0.01	0.08	0.09	.....	.....
No.38	607.00	607.50	0.50	< 5	0.3	0.02	< 0.01	0.01	2.77	3	0.18	0.01	0.19	.....	.....
No.39	607.50	608.00	0.50	< 5	0.0	0.01	< 0.01	0.01	2.44	< 1	0.12	0.01	0.13	.....	.....
No.40	608.00	608.50	0.50	< 5	0.0	0.02	< 0.01	0.01	2.93	< 1	0.02	0.02	0.04	.....	.....

Sample No.	From m	To m	Length m	Au ppb	Ag g/t	Cu %	Pb %	Zn %	Fe tot %	Re ppm	S sulfide %	S sulfate %	S tot %	S elem %	FeO %
No.41	608.50	609.00	0.50	< 5	0.0	0.03	0.01	0.02	2.73	< 1	< 0.01	0.02	0.02	.....	.....
No.42	609.00	609.50	0.50	< 5	0.3	0.12	0.02	0.01	3.34	2	0.06	0.01	0.07	.....	.....
No.43	609.50	610.00	0.50	< 5	0.3	0.04	0.03	0.01	2.57	< 1	0.03	0.01	0.04	.....	.....
No.44	435.00	435.30	0.30	< 5	0.0	< 0.01	0.01	< 0.01	4.05	5	0.01	0.02	0.03	.....	.....
No.45	440.00	440.30	0.30	< 5	0.0	0.01	0.01	0.01	3.83	< 1	1.73	0.01	1.74	0.03	2.12
No.46	445.00	445.30	0.30	< 5	0.0	0.01	< 0.01	0.01	3.84	< 1	< 0.01	0.20	0.20	.....	.....
No.47	450.00	450.30	0.30	< 5	0.0	0.01	< 0.01	< 0.01	1.02	3	0.17	0.04	0.21	.....	.....
No.48	455.00	455.30	0.30	< 5	0.0	0.01	0.05	0.01	3.00	< 1	0.03	0.01	0.04	.....	.....
No.49	460.00	460.30	0.30	< 5	0.0	< 0.01	< 0.01	0.01	3.18	3	1.10	0.01	1.11	.....	.....
No.50	465.00	465.30	0.30	< 5	0.0	< 0.01	< 0.01	0.01	3.13	< 1	0.81	0.01	0.82	.....	.....
No.51	470.00	470.30	0.30	< 5	0.0	< 0.01	0.01	0.01	2.38	< 1	0.07	0.03	0.10	.....	.....
No.52	475.00	475.30	0.30	< 5	0.0	< 0.01	< 0.01	< 0.01	2.70	< 1	0.38	0.01	0.39	.....	.....
No.53	480.00	480.30	0.30	< 5	0.0	0.02	< 0.01	0.01	3.92	2	0.01	0.02	0.03	.....	.....
No.54	485.00	485.30	0.30	< 5	0.0	< 0.01	0.01	< 0.01	1.80	< 1	0.03	0.01	0.04	.....	.....
No.55	490.00	490.30	0.30	< 5	0.0	0.01	0.01	< 0.01	1.47	< 1	0.71	0.02	0.73	0.02	0.72
No.56	495.00	495.30	0.30	< 5	0.0	0.01	0.01	< 0.01	3.50	< 1	1.58	0.01	1.59	.....	.....
No.57	500.00	500.30	0.30	< 5	0.0	0.01	< 0.01	< 0.01	2.40	2	1.13	0.02	1.15	.....	.....
No.58	505.00	505.30	0.30	< 5	0.0	0.01	< 0.01	0.01	4.09	< 1	0.01	0.02	0.03	.....	.....
No.59	510.00	510.30	0.30	< 5	0.0	0.01	< 0.01	< 0.01	4.04	< 1	0.01	0.01	0.02	.....	.....
No.60	515.00	515.30	0.30	< 5	0.0	0.01	< 0.01	0.01	3.34	1	0.72	0.02	0.74	.....	.....
No.61	520.00	520.30	0.30	< 5	0.0	0.01	< 0.01	0.01	4.22	< 1	2.54	0.02	2.56	.....	.....
No.62	525.00	525.30	0.30	< 5	0.3	0.07	0.01	0.01	3.09	< 1	1.07	0.02	1.09	.....	.....
No.63	530.00	530.30	0.30	< 5	0.0	0.01	< 0.01	0.01	3.42	< 1	0.02	0.30	0.32	.....	.....
No.64	535.00	535.30	0.30	< 5	0.3	0.01	< 0.01	0.01	3.94	< 1	0.02	0.18	0.20	.....	.....
No.65	540.00	540.30	0.30	< 5	0.0	0.01	< 0.01	0.01	3.93	< 1	0.06	0.09	0.15	0.01	3.61
No.66	545.00	545.30	0.30	< 5	0.0	0.01	< 0.01	0.01	4.14	4	< 0.01	0.02	0.02	.....	.....
No.67	550.00	550.30	0.30	< 5	0.3	0.01	< 0.01	0.01	2.25	2	0.30	0.01	0.31	.....	.....
No.68	555.00	555.30	0.30	< 5	0.0	< 0.01	< 0.01	0.02	4.82	2	0.03	0.00	0.03	.....	.....
No.69	560.00	560.30	0.30	< 5	0.0	0.02	0.03	0.01	2.14	< 1	0.07	0.01	0.08	.....	.....
No.70	565.00	565.30	0.30	< 5	0.0	0.01	0.01	0.01	3.23	6	0.37	0.01	0.38	.....	.....
No.71	570.00	570.30	0.30	< 5	0.0	< 0.01	< 0.01	< 0.01	2.64	2	0.05	0.00	0.05	.....	.....
No.72	575.00	575.30	0.30	< 5	0.0	< 0.01	< 0.01	0.01	2.55	< 1	0.09	0.01	0.10	.....	.....
No.73	580.00	580.30	0.30	< 5	0.0	0.03	0.01	0.01	2.69	2	0.04	0.01	0.05	.....	.....
No.74	585.00	585.30	0.30	< 5	0.3	0.02	< 0.01	0.01	2.65	< 1	0.07	0.01	0.08	.....	.....
No.75	621.00	621.30	0.30	< 5	0.0	0.01	0.01	< 0.01	1.60	3	< 0.01	0.02	0.02	0.02	0.71
No.76	642.00	642.30	0.30	< 5	0.0	0.01	< 0.01	0.01	4.05	< 1	< 0.01	0.03	0.03	.....	.....
No.77	Zhezkazgan South Mine			65	798.8	31.90	0.08	< 0.01	3.97	29	10.42	0.00	10.42	.....	.....
No.78	Zhezkazgan South Mine			5	459.4	27.70	0.02	< 0.01	4.59	40	10.41	0.00	10.41	.....	.....
No.79	Zhezkazgan South Mine			< 5	778.3	29.90	0.01	< 0.01	3.80	48	9.94	0.00	9.94	.....	.....
No.80	Zhezkazgan South Mine			< 5	1028.6	30.90	0.01	< 0.01	1.85	17	8.73	0.00	8.73	.....	.....

Appendix 8 Whole Rock Analysis of Samples from Drill Hole "MJK-1"

Sample No.	Depth m	Depth m	Formation	SiO_2 (%)	Al_2O_3 (%)	TiO_2 (%)	Fe_2O_3 (%)	FeO (%)	CaO (%)	MnO (%)	Na_2O (%)	MgO (%)	K_2O (%)	P_2O_5 (%)	LOI (%)	Total (%)
95-N45J3	440.00	440.30	C3dz	60.75	14.04	0.58	3.30	2.26	3.53	0.11	3.74	2.26	2.31	0.14	5.73	98.75
95-N55J3	490.00	490.30	C3dz	59.01	9.78	0.47	1.41	0.78	11.85	0.27	4.57	0.39	0.66	0.10	9.61	98.90
95-N65J3	540.00	540.30	C3dz	56.11	14.54	0.62	1.61	3.87	5.13	0.16	2.52	2.55	3.21	0.16	7.69	98.17
95-N22J3	600.77	601.75	C3dz	65.10	9.86	0.32	0.14	2.04	5.14	0.11	3.05	0.57	1.94	0.08	3.84	92.19
95-N26J3	603.10	603.66	C3dz	70.03	10.00	0.37	0.04	1.86	5.50	0.09	3.73	0.53	1.56	0.09	5.27	99.07

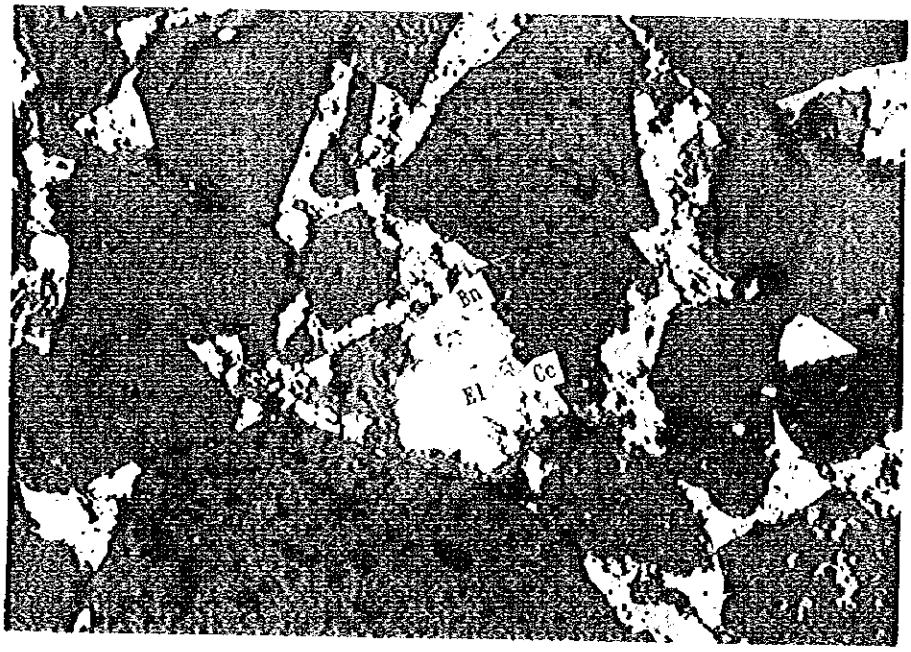
Appendix 9 Microscopic Observation of Ore Minerals in Polished Section

Sample No.	DDH No	Depth from (m)	Depth to (m)	Orebody /Horizon	Ore Type	Observation	Mineral composition Cc	Bn	Cv	El	Dz	Gr-Cb	Go
95-PS-01	MJK-1	599.82	600.02	Eastern	Cu ore	Chalcocite-like minerals mainly chalcocite and small amounts of digenite and djurleite(60%), bornite (38%), electrum (1%), goethite(1%), and gangue minerals are constituent minerals. Chalcocite-like minerals and bornite occur as interstice-filling product among sedimentary particles and as veinlets in clay-rich parts of the rocks. Ag-rich electrum (max 0.1㎜ in size) occurs in veinlets of less than 2 ㎜ in width, which consist of chalcocite-like minerals (mainly chalcocite) and less bornite, in dark bluish green clay.	○	○		+			+
95-PS-02	MJK-1	600.40	600.77	Eastern	Cu ore	Chalcocite-like minerals mainly chalcocite (95%), goethite (4%), covellite (1%) and gangue minerals are constituent minerals. Chalcocite-like minerals are interstitial among sedimentary particles. Aggregates of goethite grains as secondary products probably after pyrite within some of sedimentary particles are also observed.	○		+				△
95-PS-03	MJK-1	600.77	601.75	Eastern	Cu ore	Chalcocite-like minerals (mainly chalcocite, less digenite and rare djurleite)(98%), goethite (2%) and gangue minerals are constituent minerals. Chalcocite-like minerals occur interstice-filling products among sedimentary particles, and also within some of the particles. Goethite occurs as secondary products after pyrite.	○						△
95-PS-04	MJK-1	601.75	602.17	Eastern	Cu ore	This constitutes chalcocite-like minerals (chalcocite ＞ digenite ＞ djurleite) (80%), bornite (19%), gersdorffite-cobaltite series mineral (1%) and gangue minerals. Chalcocite-like minerals occur as aggregates of small grains and dots and occasionally as patches up to 3 ㎜ × 5 ㎜ in size. Bornite occurs as small inclusions in chacocite-like minerals and as anhedral grains with chalcocite-like minerals up to 40 ㎛ in size. In such a case, these minerals tend to arrange linearly in the rock .Gersdorffite-cobaltite series mineral occurs as small euhedral crystals in chalcocite-like minerals generally with bornite inclusion, and might be misunderstood as skutterudite by Russian researcher.	○	○				+	
95-PS-05	MJK-1	602.17	602.68	Eastern	Cu ore	Chalcocite-like minerals (mainly chalcocite and less digenite) (97%), bornite (1%), covellite (1%) and gangue minerals are constituent minerals. Chalcocite-like minerals occur interstitially among sedimentary particles. Bornite rarely occurs as small inclusions in chalcocite-like minerals. In such a case, bornite is surrounded by secondary djurleite which is an alteration product after chalcocite. Covellite and goethite are also secondary products after chalcocite-like minerals and probably pyrite, respectively.	○	+	+				+
95-PS-06	MJK-1	602.68	603.10	Eastern	Cu ore	This polished section consist of chalcocite-like minerals (mainly chalcocite) (98%), bornite (1%), goethite (1%), and gangue minerals. Interstitial chalcocite-like minerals among sedimentary particles are predominant. Bornite occurs as small inclusion in chalcocite-like minerals. Goethite occurs as secondary products after pyrite in some of sedimentary particles.	○	+					+
95-PS-07	MJK-1	605.00	605.20	Eastern	Cu ore	This is also composed of chalcocite-like minerals (mainly chalcocite) (99%), goethite (1%) and gangue minerals. Chalcocite-like minerals occur as interstice-filling products among sedimentary particles. Goethite occurs in some of sedimentary particles as secondary products after pyrite.	○						+
95-PS-08	MJK-1	605.20	605.34	Eastern	Cu ore	This polished section consists of chalcocite-like minerals (mainly chalcocite and less digenite) (99%), goethite (1%) and gangue minerals. Chalcocite-like minerals occur as interstice-filling products among sedimentary particles. The sulphide minerals are generally more concentrated in sandy parts than silty parts.	○						+
95-PS-09	MJK-1	605.47	605.61	Eastern	Cu ore	Chalcocite-like minerals (mainly chalcocite) (97%), electrum (2%), goethite (1%) and gangue minerals are constituent minerals. Chalcocite-like minerals interstitially occur among sedimentary particles. Ag-rich electrum occurs as small inclusions up to 50 ㎛ in size in open spaces in chalcocite-like minerals and in direct contact with chalcocite-like minerals. Goethite occurs as secondary products after pyrite.	○			△			+
95-PS-10		Zhezkazgan Mine		South Mine	Cu ore (high grade ore)	Sulphide minerals is predominant. It is composed of chalcocite-like minerals (mainly chalcocite) (60%), bornite (39%), electrum (1%) and gangue minerals. All of these ore minerals occur as interstice-filling products among sedimentary particles with quartz and other gangue minerals which occur as euhedral crystals. Chalcocite-like minerals and bornite coexist with each other. Ag-rich electrum is included within both chalcocite-like minerals and bornite, and the former case is rather common. Rarely "dzhezkazganite"-like minerals (?) occurs in chalcocite-like minerals, but it is difficult to identify this phase because of its tiny size.	○	○		+	+ ?		

Cc : chalcocite-like minerals Bn : bornite Cv : covellite El : electrum Dz : zhezkazganite Gr-Cb : gersdorffite-cobaltite series mineral Go : goethite

Sample No. : 95-PS-01
DDH No. : MJK-1
Depth : 599.82m
Orebody : Eastern
Ore Horizon : 4-I
Ore Type : Cu-Ore

0.5mm

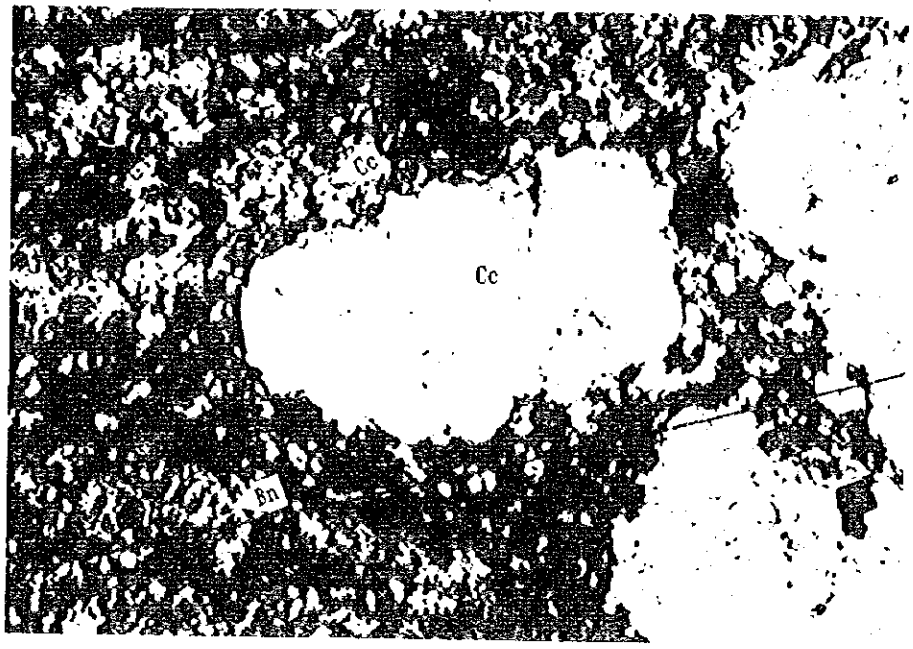


Sample No. : 95-PS-01
DDH No. : MJK-1
Depth : 599.82m
Orebody : Eastern
Ore Horizon : 4-I
Ore Type : Cu-Ore

0.5mm

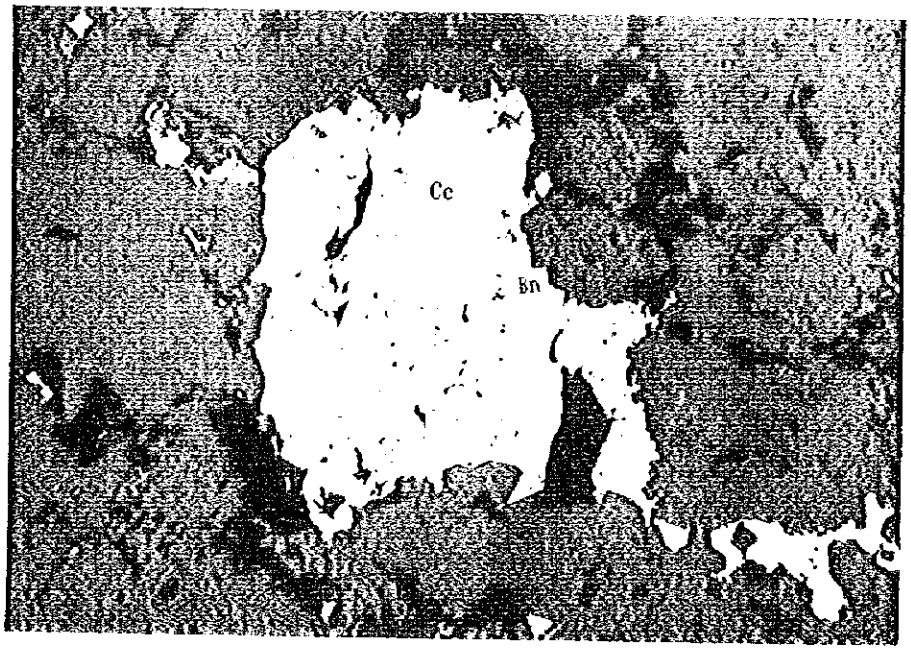
Cc : Chalcocite
Bn : Bornite
El : Electrum

Appendix 10 Photomicrographs of Ore Minerals in Polished Sections



Sample No. : 95-PS-04
DDH No. : MJK-1
Depth : 601.75m
Orebody : Eastern
Ore Horizon : 4-I
Ore Type : Cu-Ore

0.5mm

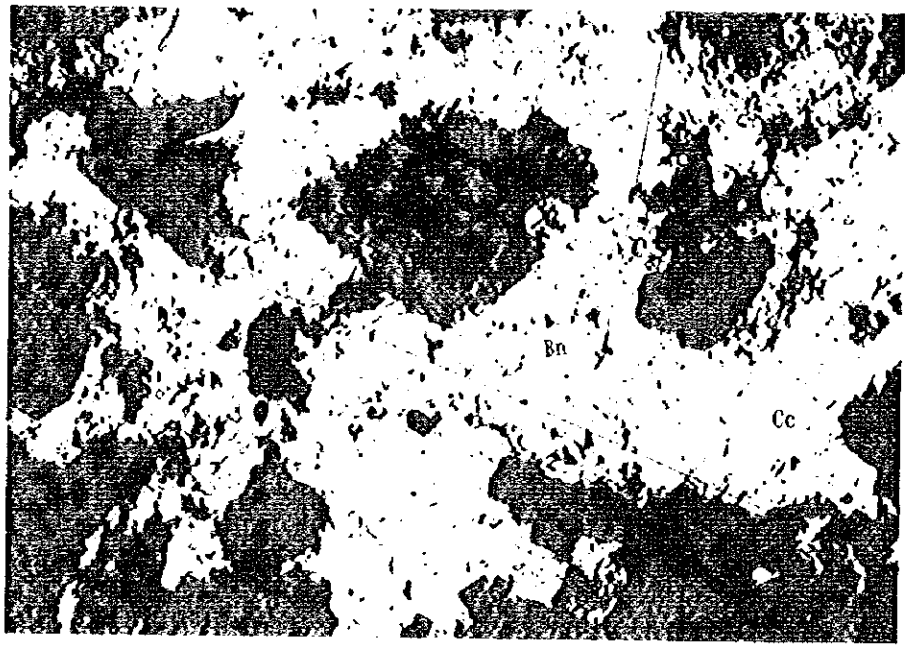


Sample No. : 95-PS-05
DDH No. : MJK-1
Depth : 602.10m
Orebody : Eastern
Ore Horizon : 4-I
Ore Type : Cu-Ore

0.5mm

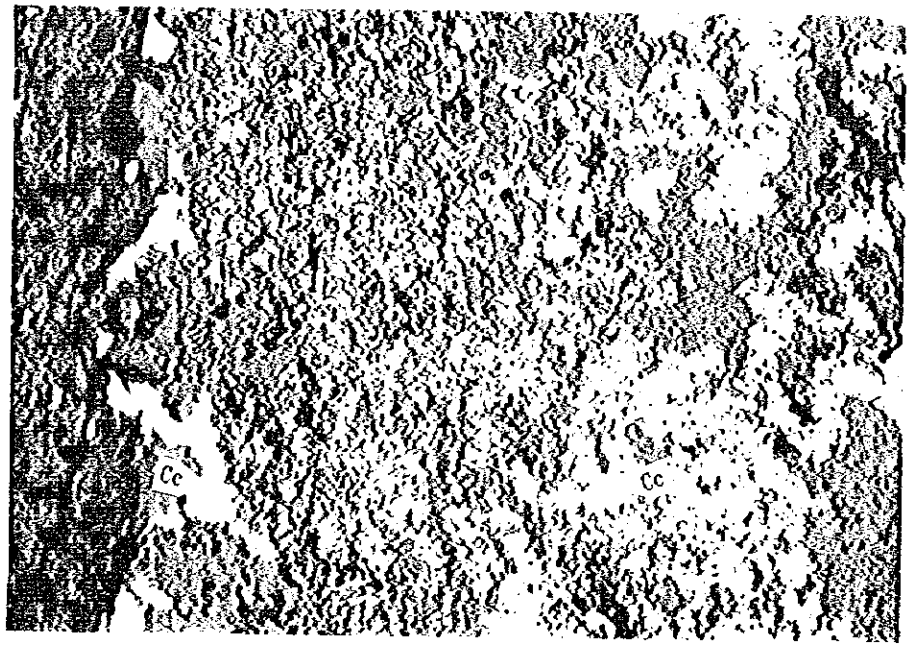
Cc : Chalcocite
Bn : Bornite

Appendix 10 Photomicrographs of Ore Minerals in Polished Sections



Sample No. : 95-PS-06
DDH No. : MJK-1
Depth : 602.68m
Orebody : Eastern
Ore Horizon : 4-I
Ore Type : Cu-Ore

0.5mm



Sample No. : 95-PS-08
DDH No. : MJK-1
Depth : 605.20m
Orebody : Eastern
Ore Horizon : 4-I
Ore Type : Cu-Ore

0.5mm

Cc : Chalcocite
Bn : Bornite

Appendix 10 Photomicrographs of Ore Minerals in Polished Sections

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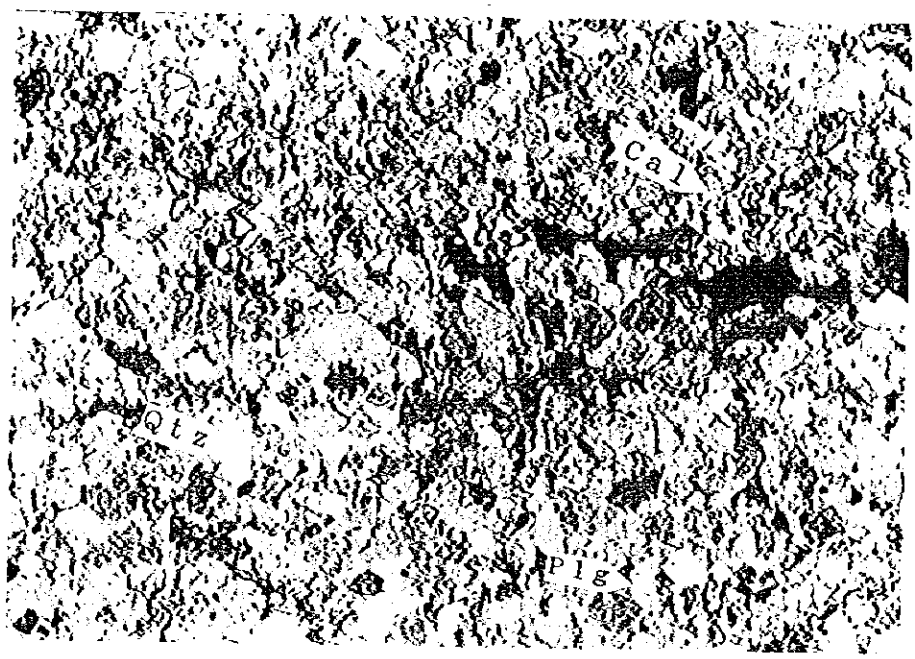
Appendix 11 Results of EPMA Semi-Quantitative Analysis of Ores from MJK-1 and the Zhezkazgan Deposit

No.	Fe (wt %)	Cu (wt %)	Ag (wt %)	Pb (wt %)	S (wt %)	Total (wt %)	Minerals
95-EP-01	10.63	66.656	0	0	23.801	101.087	bornite
(field code : No.23)	11.451	65.623	0.009	0	23.854	100.937	bornite
	11.28	64.029	0.032	0	23.692	99.033	bornite
	0.055	82.068	0	0	19.361	101.484	chalcocite
	0.076	82.192	0.04	0	18.951	101.259	chalcocite
	0.158	47.695	23.994	0	15.925	87.772	stromeyerite
	0.322	78.741	1.608	0	20.199	100.87	chalcocite
95-EP-02	0	0.185	0	86.638	13.505	100.328	galena
(field code : No.19)	0	0.037	0	86.392	13.211	99.64	galena
	10.69	64.588	0.014	0	23.929	99.221	bornite
	10.866	64.723	0	0	23.85	99.439	bornite
	0.041	82.831	0.026	0	19.497	102.395	chalcocite
	0.029	82.263	0	0	19.495	101.787	chalcocite
95-EP-03	11.292	64.929	0.297	0	24.042	100.56	bornite
(field code : No.80)	11.286	64.956	0.212	0	23.835	100.289	bornite
	0.022	82.186	0.395	0	19.038	101.641	chalcocite
	0.023	83.572	0.353	0	19.054	103.002	chalcocite

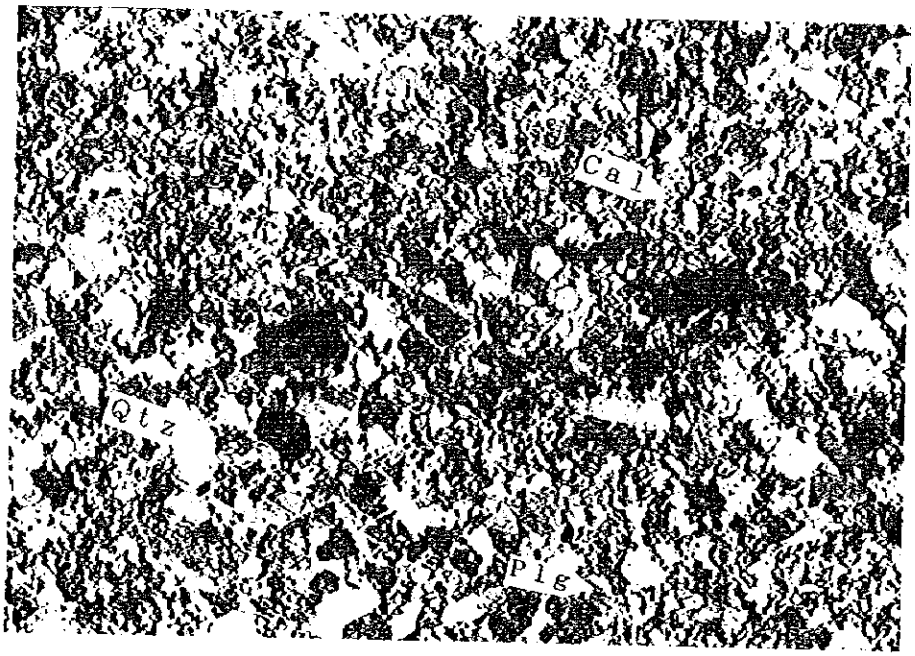
Appendix 12 Microscopic Observation of Rock on Thin Sections

Sample No.	DDH No.	Depth m	Depth m	Formaton	Rock Name	Description	Identified Minerals
95-TS-01	MJK-1	203.5		P1Zd	Laminated siltstone (red aleurolite)	average diameter : 0.02~0.05mm ϕ matrix : carbonitization (weak)	quartz, plagioclase, K-feldspar, sericite, chlorite, smectite, goethite(?)
95-TS-02	MJK-1	329.4		P1Zd	Calcareous sandstone (red sandstone)	average diameter : 0.15mm ϕ matrix : carbonitization	quartz, carbonate minerals (mostly calcite), plogioclase, K-feldspar, opeque minerals, chlorite
95-TS-03	MJK-1	458.9	459.0	C3Dz	Thin laminated siltstone	average diameter : 0.02~0.05mm ϕ matrix : carbonitization	quartz, plagioclase, K-feldspar, opeque-minerals, carbonate minerals (mostly calcite), smectite
95-TS-04	MJK-1	539.9	540.0	C3Dz	Thin laminated siltstone	average diameter : 0.15~0.05mm ϕ matrix : carbonitization	quartz, plagioclase, K-feldspar, opeque minerals, carbonate minerals (mainly calcite), chlorite
95-TS-05	MJK-1	586.2	586.3	C3Dz	Calcareous fine-grained laminated sandstone	average diameter : 0.15mm ϕ matrix : carbonitization	quartz, plagioclase, K-feldspar, opeque minerals, carbonate minerals (mainly calcite),
95-TS-06	MJK-1	601.5		C3Dz	Thin bedded (or laminated) sandstone	average diameter : 0.4mm ϕ matrix : carbonitization, copper minerals	quartz, plagioclase, K-feldspar, opeque minerals, carbonate minerals (mainly calcite), tourmaline
95-TS-07	MJK-1	644.2	644.25	C2tz	Calcareous sandstone	average diameter : 0.2mm ϕ matrix : carbonitization	quartz, plagioclase, K-feldspar, opeque minerals, carbonate minerals (mainly calcite), sericite, chlorite, smectite



Open Polar

4 mm

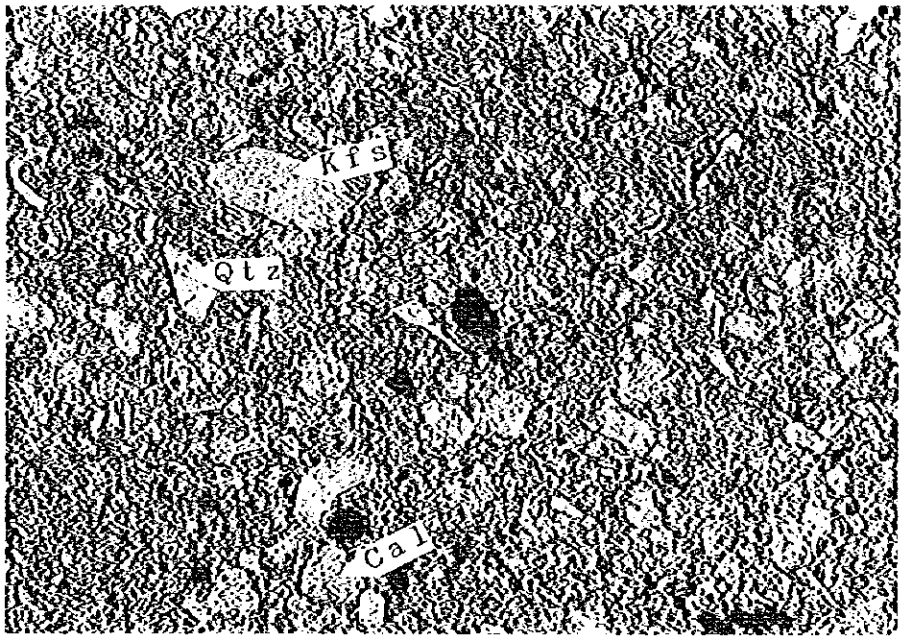


Crossed Polars

4 mm

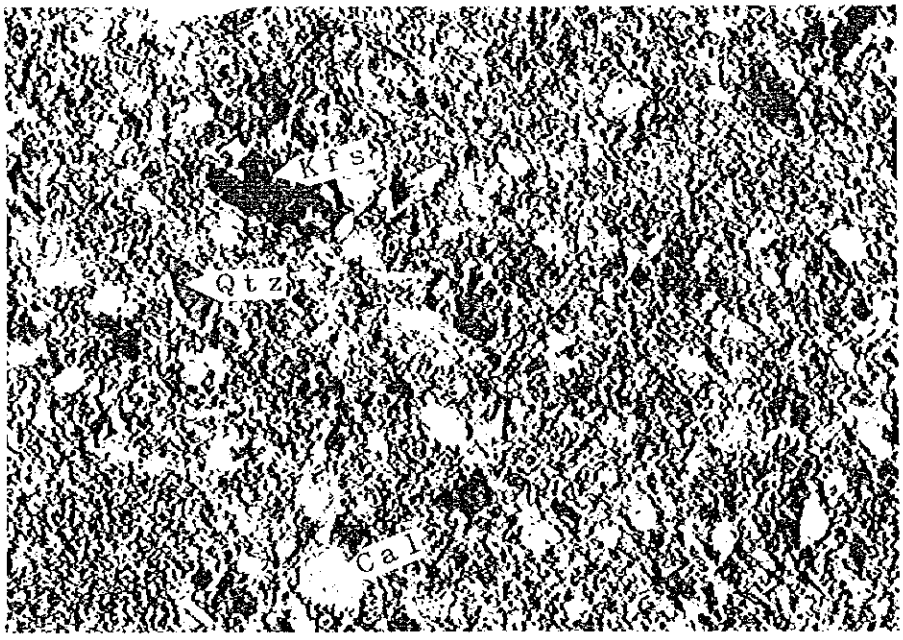
Cal : Calcite
Qtz : Quartz
Plg : Plagioclase

Sample No. : 95-TS-02
DDH No. : MJK-1
Depth : 329.40m
Formation : Zhidelisai
Rock Name : Calcareous Sandstone



Open Polar

0.5mm

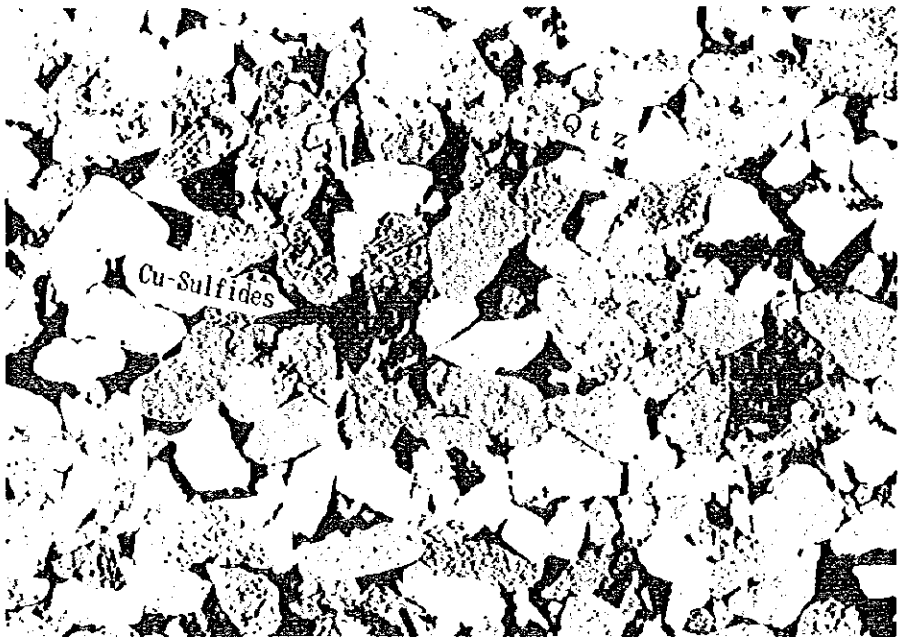


Crossed Polars

0.5mm

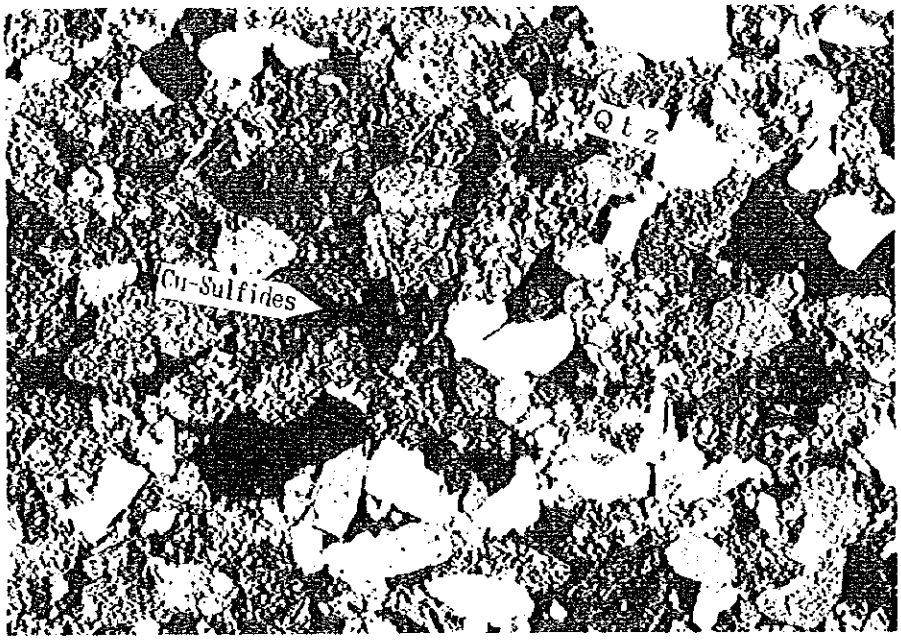
Cal : Calcite
Qtz : Quartz
Kfs : K-feldspar

Sample No. : 95-TS-04
DDH No. : MJK-1
Depth : 539.90m
Formation : Zhezkazgan
Rock Name : Thin Laminated Siltstone



Open Polar

4 mm



Crossed Polars

4 mm

Qtz : Quartz
Cu-Sulfides : Chalcocite, Bornite

Sample No. : 95-TS-06
DDH No. : MJK-1
Depth : 601.50m
Formation : Zhezkazgan
Rock Name : Thin Bedded or Laminated Sandstone (Cu-Ore)

Appendix 13 Photomicrographs of Rocks in Thin Sections

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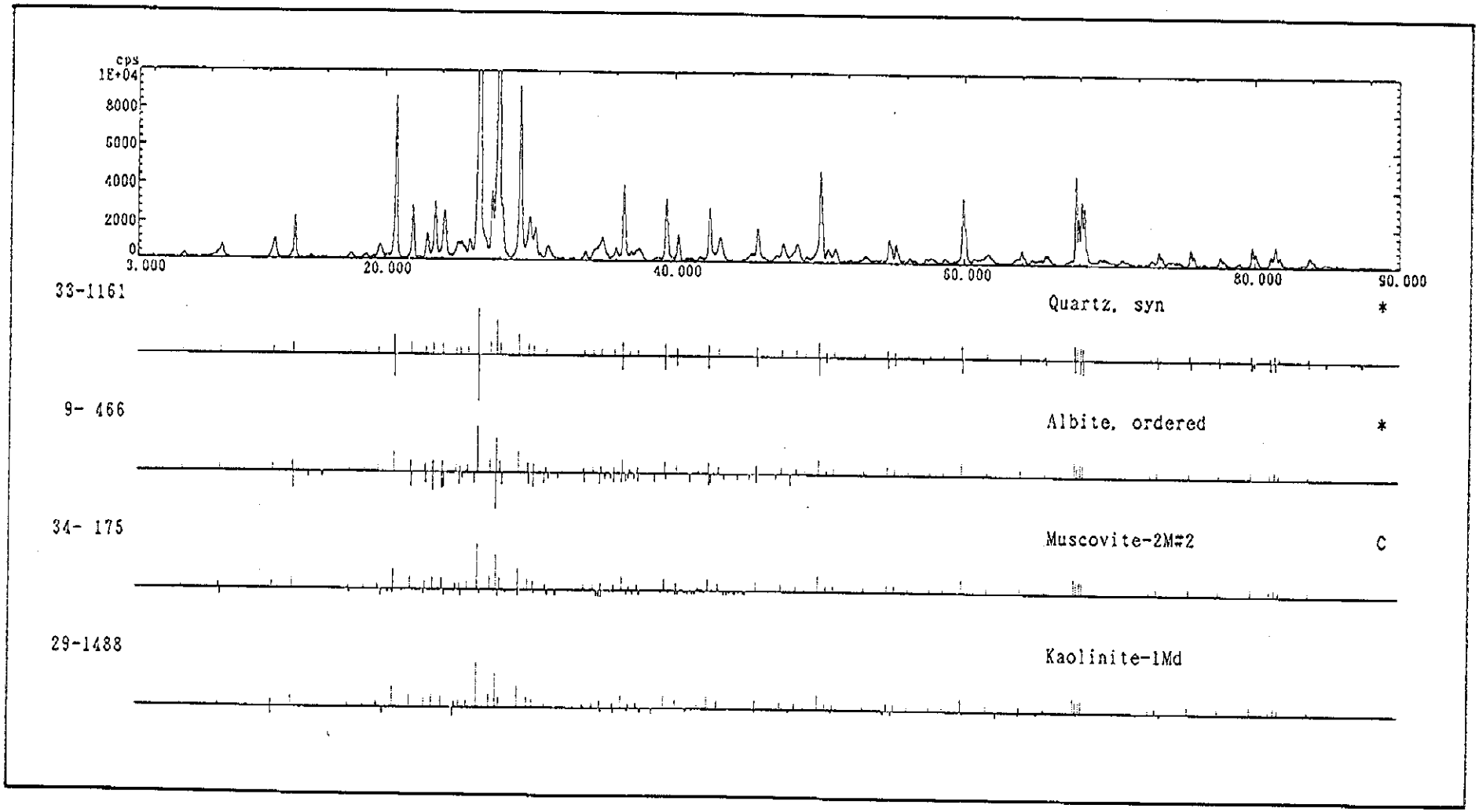
Appendix 14 Results of X-ray Diffration Analysis of Feed Ore

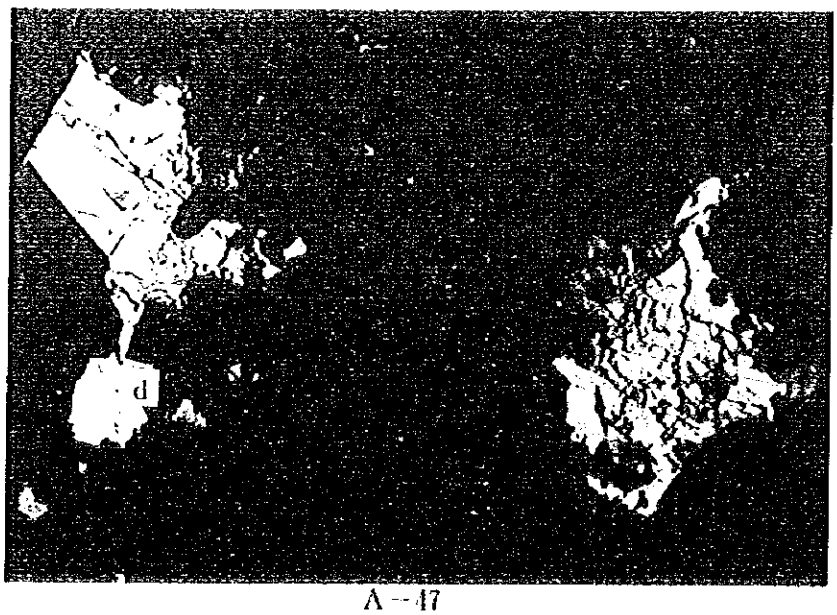


Appendix 15(1) Photomicrographs of Ore Minerals in Polished Sections
(Feed Ore of Ore Dressing Test)

Feed Ore

25μm
360×

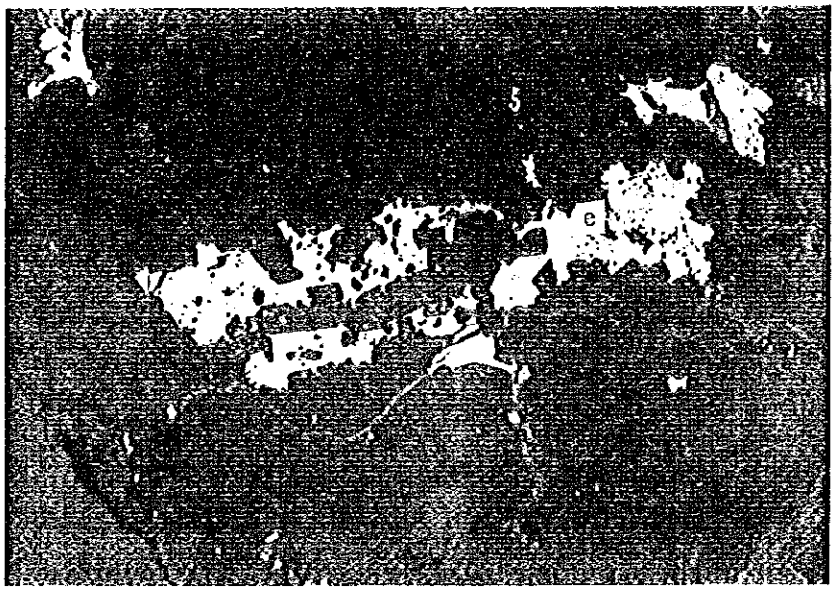
25μm
360×



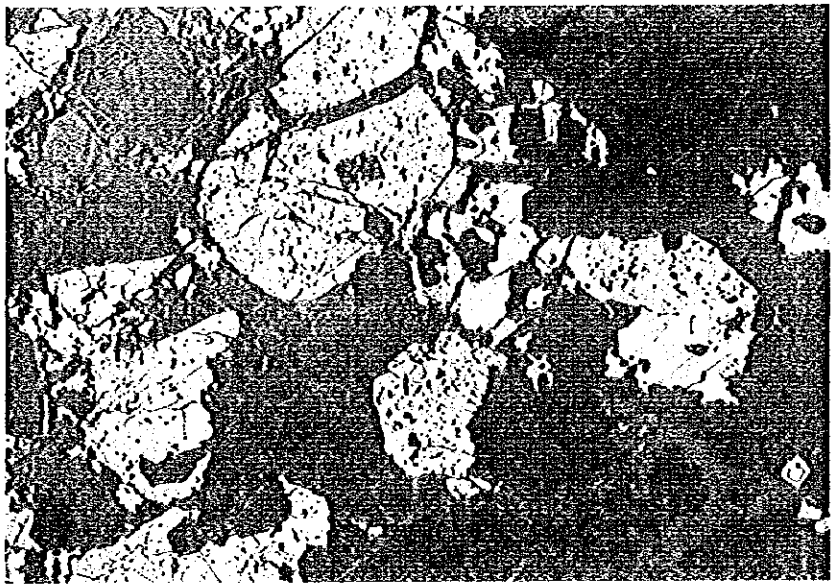
25μm
360×

Appendix 15(2) Photomicrographs of Ore Minerals in Polished Sections
(Feed Ore of Ore Dressing Test)

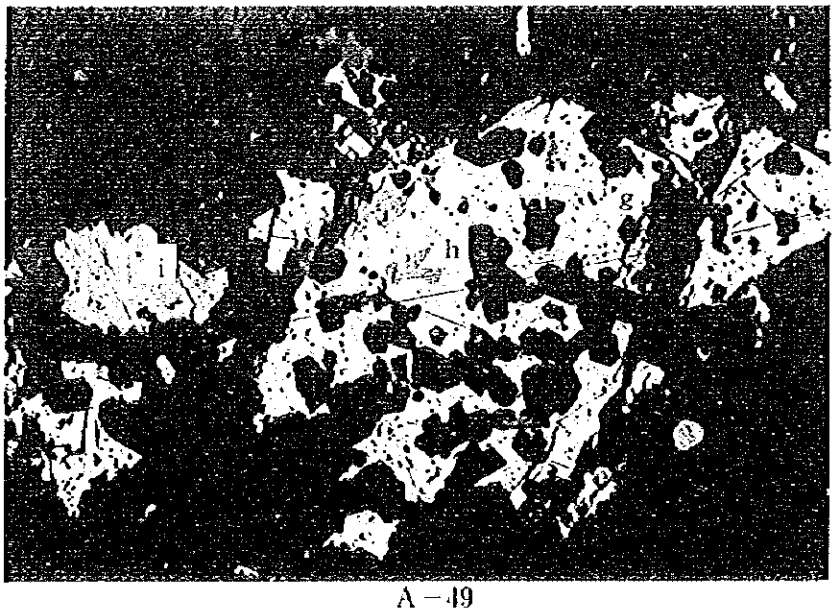
Feed Ore



50μm
180×



50μm
180×



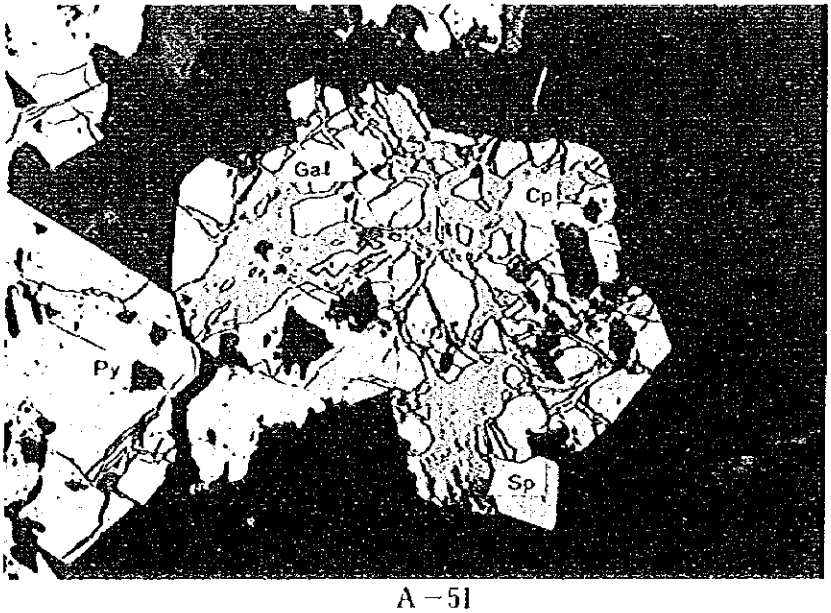
50μm
180×

Appendix 15(3) Photomicrographs of Ore Minerals in Polished Sections
(Feed Ore of Ore Dressing Test)

Feed Ore

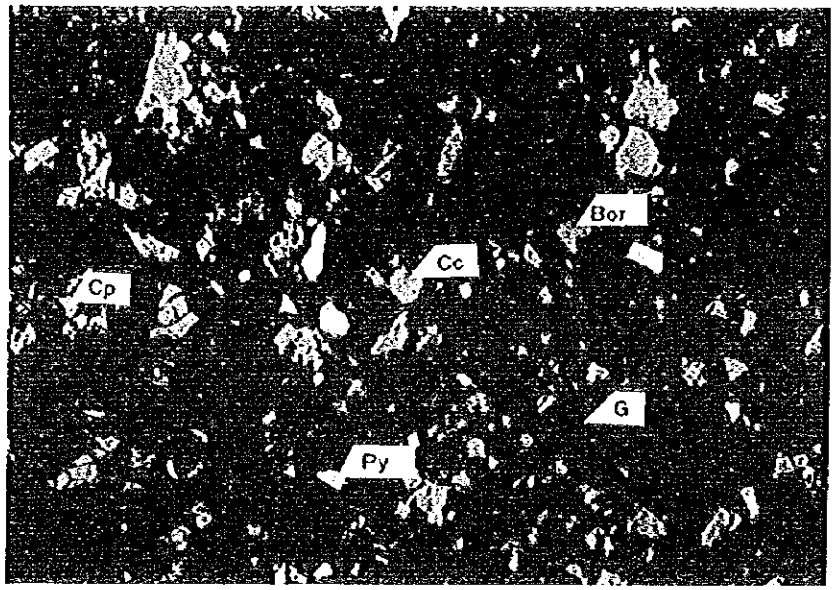
25μm
360×

50μm
180×



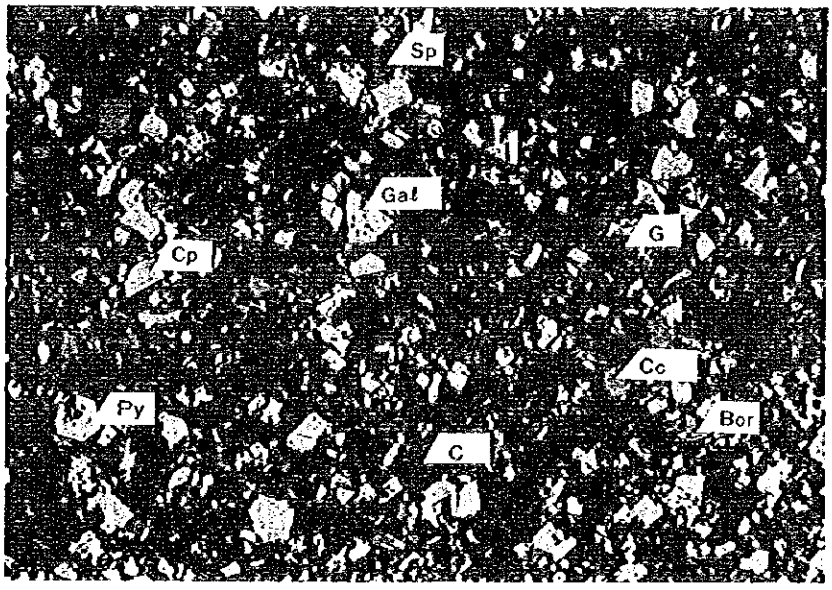
25μm
360×

Appendix 15(4) Photomicrographs of Ore Minerals in Polished Sections
(Concentrates and Tailing)



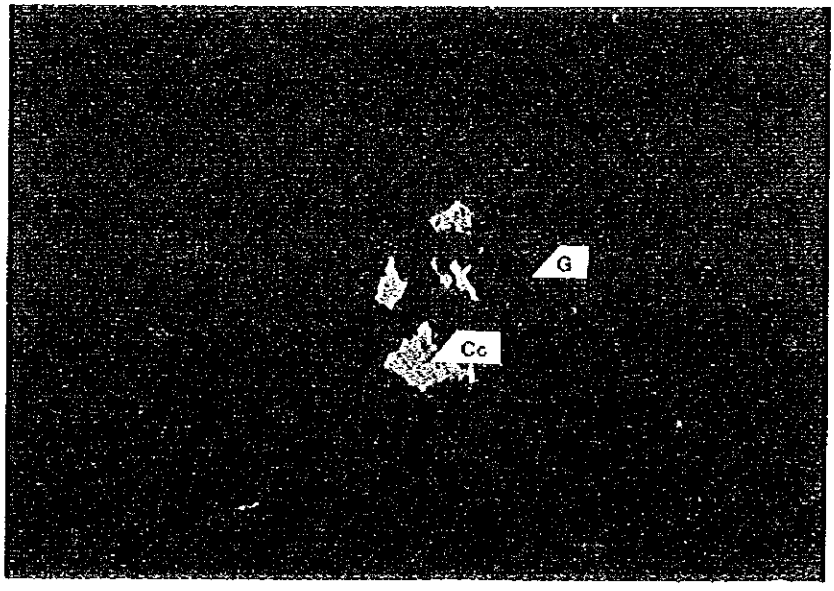
Copper Concentrate

50μm
180×



Lead Concentrate

50μm
180×



Tailing

20μm
450×

Appendix 16 Results of Griding Tests

Test No. 5+5 Grind

	Products	Weight (g)	Weight (%)	Assay (%) Cu	Pb	S	Distribution (%) Cu	Pb	S
	Feed	494.2	100.00	1.72	0.52	1.01	100.00	100.00	100.00
1	+149μm	71.9	14.55	1.08	0.21	0.58	9.14	5.89	8.34
2	+105μm	104.4	21.13	1.20	0.25	0.72	14.75	10.19	15.03
3	+ 75μm	82.1	16.61	1.69	0.36	0.98	16.33	11.53	16.09
4	+ 45μm	64.2	12.99	2.22	0.54	1.19	16.78	13.53	15.28
5	+ 20μm	63.8	12.91	2.92	0.86	1.62	21.93	21.41	20.67
6	- 20μm	107.8	21.81	1.66	0.89	1.14	21.07	37.45	24.59
	1+2	176.3	35.68	1.15	0.23	0.66	23.89	16.08	23.37
	1+2+3	258.4	52.29	1.32	0.27	0.76	40.22	27.61	39.46
	1+2+3+4	322.6	65.28	1.50	0.33	0.85	57.00	41.14	54.74
	1+2+3+4+5	386.4	78.19	1.74	0.41	0.98	78.93	62.55	75.41
	5+6	171.6	34.72	2.13	0.88	1.32	43.00	58.86	45.26
	4+5+6	235.8	47.71	2.15	0.79	1.28	59.78	72.39	60.54
	3+4+5+6	317.9	64.32	2.03	0.68	1.21	76.11	83.92	76.63
	2+3+4+5+6	422.3	85.45	1.83	0.57	1.09	90.86	94.11	91.66

Test No. 7.5+7.5 Grind

	Products	Weight (g)	Weight (%)	Assay (%) Cu	Pb	S	Distribution (%) Cu	Pb	S
	Feed	464.1	100.00	1.70	0.52	1.04	100.00	100.00	100.00
1	+149μm	18.0	3.88	0.68	0.15	0.40	1.55	1.11	1.50
2	+105μm	63.3	13.64	0.77	0.18	0.48	6.17	4.69	6.32
3	+ 75μm	94.8	20.43	1.26	0.30	0.84	15.12	11.71	16.58
4	+ 45μm	89.9	19.37	1.89	0.45	1.15	21.50	16.66	21.52
5	+ 20μm	90.3	19.46	2.71	0.72	1.54	30.97	26.77	28.95
6	- 20μm	107.8	23.22	1.81	0.88	1.12	24.69	39.06	25.13
	1+2	81.3	17.52	0.75	0.17	0.46	7.72	5.80	7.82
	1+2+3	176.1	37.95	1.02	0.24	0.67	22.84	17.51	24.40
	1+2+3+4	266.0	57.32	1.32	0.31	0.83	44.34	34.17	45.92
	1+2+3+4+5	356.3	76.78	1.67	0.42	1.01	75.31	60.94	74.87
	5+6	198.1	42.68	2.22	0.81	1.31	55.66	65.83	54.08
	4+5+6	288.0	62.05	2.12	0.70	1.26	77.16	82.49	75.60
	3+4+5+6	382.8	82.48	1.90	0.60	1.16	92.28	94.20	92.18
	2+3+4+5+6	446.1	96.12	1.74	0.54	1.06	98.45	98.89	98.50

Test No. 10+10 Grind

	Products	Weight (g)	Weight (%)	Assay (%) Cu	Pb	S	Distribution (%) Cu	Pb	S
	Feed	495.3	100.00	1.74	0.54	0.98	100.00	100.00	100.00
1	+105μm	32.8	6.62	0.57	0.12	0.38	2.16	1.48	2.57
2	+ 75μm	68.7	13.87	0.90	0.19	0.56	7.16	4.90	7.93
3	+ 45μm	116.6	23.54	1.57	0.34	0.88	21.19	14.87	21.16
4	+ 20μm	114.6	23.14	2.60	0.64	1.36	34.49	27.51	32.13
5	- 20μm	162.6	32.83	1.86	0.84	1.08	35.00	51.24	36.21
	1+2	101.5	20.49	0.79	0.17	0.50	9.32	6.38	10.50
	1+2+3	218.1	44.03	1.21	0.26	0.70	30.51	21.25	31.66
	1+2+3+4	332.7	67.17	1.69	0.39	0.93	65.00	48.76	63.79
	4+5	277.2	55.97	2.17	0.76	1.20	69.49	78.75	68.34
	3+4+5	393.8	79.51	1.99	0.63	1.10	90.68	93.62	89.50
	2+3+4+5	462.5	93.38	1.83	0.57	1.02	97.84	98.52	97.43

Appendix 17 Results of Screen Analysis of Tailing

Test No. KS-1 Tail

	Products	Weight (g)	Weight (%)	Assay (%) Cu	Pb	Distribution (%) Cu	Pb
	Feed	431.0	100.00	0.20	0.05	100.00	100.00
1	+149μm	66.4	15.41	0.47	0.11	37.03	34.30
2	+105μm	95.0	22.03	0.26	0.06	29.30	26.78
3	+ 75μm	71.3	16.54	0.17	0.04	14.38	13.40
4	+ 45μm	59.6	13.83	0.11	0.03	7.78	8.40
5	+ 20μm	51.7	12.00	0.07	0.02	4.29	4.86
6	- 20μm	87.0	20.19	0.07	0.03	7.22	12.26
	1+2	161.4	37.44	0.35	0.08	66.33	61.08
	1+2+3	232.7	53.98	0.29	0.07	80.71	74.48
	1+2+3+4	292.3	67.81	0.26	0.06	88.49	82.88
	1+2+3+4+5	344	79.81	0.23	0.05	92.78	87.74
	5+6	138.7	32.19	0.07	0.03	11.51	17.12
	4+5+6	198.3	46.02	0.08	0.03	19.29	25.52
	3+4+5+6	269.6	62.56	0.11	0.03	33.67	38.92
	2+3+4+5+6	364.6	84.59	0.15	0.04	62.97	65.70

Test No. KS-2 Tail

	Products	Weight (g)	Weight (%)	Assay (%) Cu	Pb	Distribution (%) Cu	Pb
	Feed	419.9	100.00	0.10	0.03	100.00	100.00
1	+149μm	13.7	3.26	0.30	0.11	9.41	10.39
2	+105μm	56.7	13.50	0.19	0.06	24.67	23.45
3	+ 75μm	86.5	20.60	0.12	0.04	23.77	23.86
4	+ 45μm	87.6	20.86	0.09	0.03	18.05	18.12
5	+ 20μm	75.6	18.00	0.06	0.02	10.39	10.42
6	- 20μm	99.8	23.78	0.06	0.02	13.71	13.76
	1+2	70.4	16.76	0.21	0.07	34.08	33.84
	1+2+3	156.9	37.36	0.16	0.05	57.85	57.70
	1+2+3+4	244.5	58.22	0.14	0.04	75.90	75.82
	1+2+3+4+5	320.1	76.22	0.12	0.04	86.29	86.24
	5+6	175.4	41.78	0.06	0.02	24.10	24.18
	4+5+6	263.0	62.64	0.07	0.02	42.15	42.30
	3+4+5+6	349.5	83.24	0.08	0.03	65.92	66.16
	2+3+4+5+6	406.2	96.74	0.10	0.03	90.59	89.61

Test No. KS-3 Tail

	Products	Weight (g)	Weight (%)	Assay (%) Cu	Pb	Distribution (%) Cu	Pb
	Feed	420.1	100.00	0.08	0.03	100.00	100.00
1	+105μm	23.8	5.67	0.17	0.07	12.30	13.84
2	+ 75μm	68.7	16.35	0.12	0.04	25.07	22.82
3	+ 45μm	107.4	25.57	0.08	0.03	26.13	26.77
4	+ 20μm	99.6	23.71	0.06	0.02	18.17	16.54
5	- 20μm	120.6	28.70	0.05	0.02	18.33	20.03
6							
	1+2	92.5	22.02	0.13	0.05	37.37	36.66
	1+2+3	199.9	47.59	0.10	0.04	63.50	63.43
	1+2+3+4	299.5	71.30	0.09	0.03	81.67	79.97
	4+5	220.2	52.41	0.05	0.02	36.50	36.57
	3+4+5	327.6	77.98	0.06	0.02	62.63	63.34
	2+3+4+5	396.3	94.33	0.07	0.03	87.70	86.16