第３章　シラルジン地区

３－１　調査目的及び方法

本地区は第１年次調査の既存資料により抽出されたシラルジン金鉱床を中心とする範囲であり，鉱脈露頭の規模（脈幅及び延長），品位，母岩の変質及びその規模などの鉱化変質帯の平面的広がりの確認を目的とし，地質精査12km²を実施した。

調査には国家地質地下資源管理委員会所有の1/10,000地形図を縮尺1/5,000に拡大し調査基本図とした。調査はポケットコンパスあるいはクリノコンパスとＧＰＳ及び間縄を利用し，簡易測量を実施しながら地質観察事項をルートマップ上に記載した。特に主鉱体脈については閉塞測量を実施し，露頭の相対位置関係を明確に把握するように努めた。キャンプは調査地区東方に位置するクムイシュタッグ川中流に配置し，調査地まで馬を利用して調査した。

また，本地区でのボーリング調査のための搬入道路作成を，本地区北西方のベイシケ経由マンカブラック川側から実施した。作成内容はブルドーザーによる既存道路の補修14.22kmと道路新設10.11kmである。岩盤の開削はレッグ削岩機にて穿孔し，硝安油剤爆薬(ANFO)を使用して発破した。ベースキャンプはマンカブラック川最上流に設置した。ボーリングサイトの取付道路をFig.Ⅱ-3-1に示す。

３－２　地　質

本地区はサルジョン層群，チャトカラガイ層群，クムイシュタッグ花崗岩類とこれらを覆う第四紀堆積物からなる。チャトカラガイ層群は地区南東部に小規模に分布する。本調査地区の地質図をFig.Ⅱ-3-2に，地質断面図をFig.Ⅱ-3-3に示す。

３－３　調査結果

３－３－１　地質調査

シラルジン地区に分布するクムイシュタッグ花崗岩類は，肉眼鑑定により，桃色中粒花崗岩(γSdm)，桃色細粒花崗岩(γSdf)及び白色花崗斑岩(γSdp)に区分される。桃色中粒花崗岩はクムイシュタッグ花崗岩類の卓越岩相であり，本地区に広く露出する。鏡下(Apx.-2;5KS41)では，半自形粒状組織を示し，微斜長石，石英，斜長石，黒雲母を主とし，電気石，燐灰石，ジルコンが認められる。桃色細粒花崗岩は地区西部に約300m×300m，及び約200m×200mの範囲で小規模に露出している。鏡下(Apx.-2;5KS40)では，半自形粒状組織を示し，微斜長石，石英，斜長石を主とし，燐灰石，ジルコンが認められる。白色花崗斑岩は地区中央

部に露出し，東西500m，南北1,000mの変形した三日月形を呈する。肉眼では白色変質が著しくし，鏡下(Apx.-2;5KS42)では，斑状，集斑状，または半自形粒状組織を示し，斑晶は微斜長石，石英，斜長石からなり，スフェーン，ジルコン，燐灰石，黒雲母が認められる。

サルジョン層群はホルンフェルス，珪化頁岩からなり，本地区東部と南部に分布し，一部は花崗岩類中に窓状に分布する。本地区東部でのサルジョン層群との関係は，第1年次報告書では断層関係としたが，本年次の調査では破砕帯の存在やマイロナイトの形成など断層の存在を明示する露頭が観察されず，また花崗岩類周辺の砂岩・頁岩はホルンフェルス化が進み接触変成作用を受けていることが判明した。このため，本調査では花崗岩類とサルジョン層群とは貫入関係で接していると推定した。しかし，境界部は南北方向の直線状を示すことから，花崗岩類貫入に伴う断層が形成されている可能性は完全には否定できない。

3－3－2 鉱化作用

本調査地区のクムイシュタッグ花崗岩類中にはマンガン菱鉄鉱脈・石英脈からなるシラルジン金鉱床が知られている。本鉱床の主要脈の露頭をPL.12に示す。現在までのところキルギス側の調査により，主鉱体脈，中央鉱体脈，接触鉱体北部脈及び接触鉱体南部脈の4鉱脈が発見されている。

主鉱体脈は地区最高峰の標高2,893mピークの東100m付近に露出し，延長約1,400m，幅0.6～3.7mであり，走向はN10°Eを示す。尾根上の露頭での傾斜は35°～48°Wであるが，斜面上での脈の傾斜は75°Wである

接触鉱体北部脈は主鉱体脈の東1,000m付近の，サルジョン層群との境界周辺部の花崗岩類中，一部はサルジョン層のホルンフェルスに胚胎し，延長200mと400mの露出部が認められる。脈幅は0.4～0.8mで，走向はN5°E～N20°E，傾斜は40°～80°Wを示す。

接触鉱体南部脈は，接触鉱体北部脈の南方延長約1kmに位置し，長さ200mと300mの露出部に二分される。脈幅は0.3～0.75mで，走向はN5°E～N20°E，傾斜は50°～82°Wを示す。

主鉱体脈の10のトレンチスケッチをFig.II-3-4に，接触鉱体北部脈中の坑道スケッチをFig.II-3-5に示す。マンガン菱鉄鉱脈・石英脈は淡緑白色を呈するグライゼン中に産し，時に鉱脈の上下盤は幅0.1～0.3mの白色粘土帯をもってグライゼンと境する。さらにグライゼンは弱グライゼン化花崗岩を経て非変質花崗岩に漸移する。

本調査地区内に分布するマンガン菱鉄鉱・石英脈について，試料の分析を実施した。分析結果をApx.-6に示す。本地区で最も優勢な主鉱体脈の品位は，Au 1.0～19.6 g/t，Ag 1～6.6g/t，Cu 0.28～2.6%であり，接触鉱体南部脈では，Au 1.8～28.4g/t，Ag 1～3.6g/t，Cu 0.18～3.4%，接触鉱体北部脈では，Au 0.6～9.7g/t，Ag 0.3～3.2g/t，Cu 0.06～2.6%で

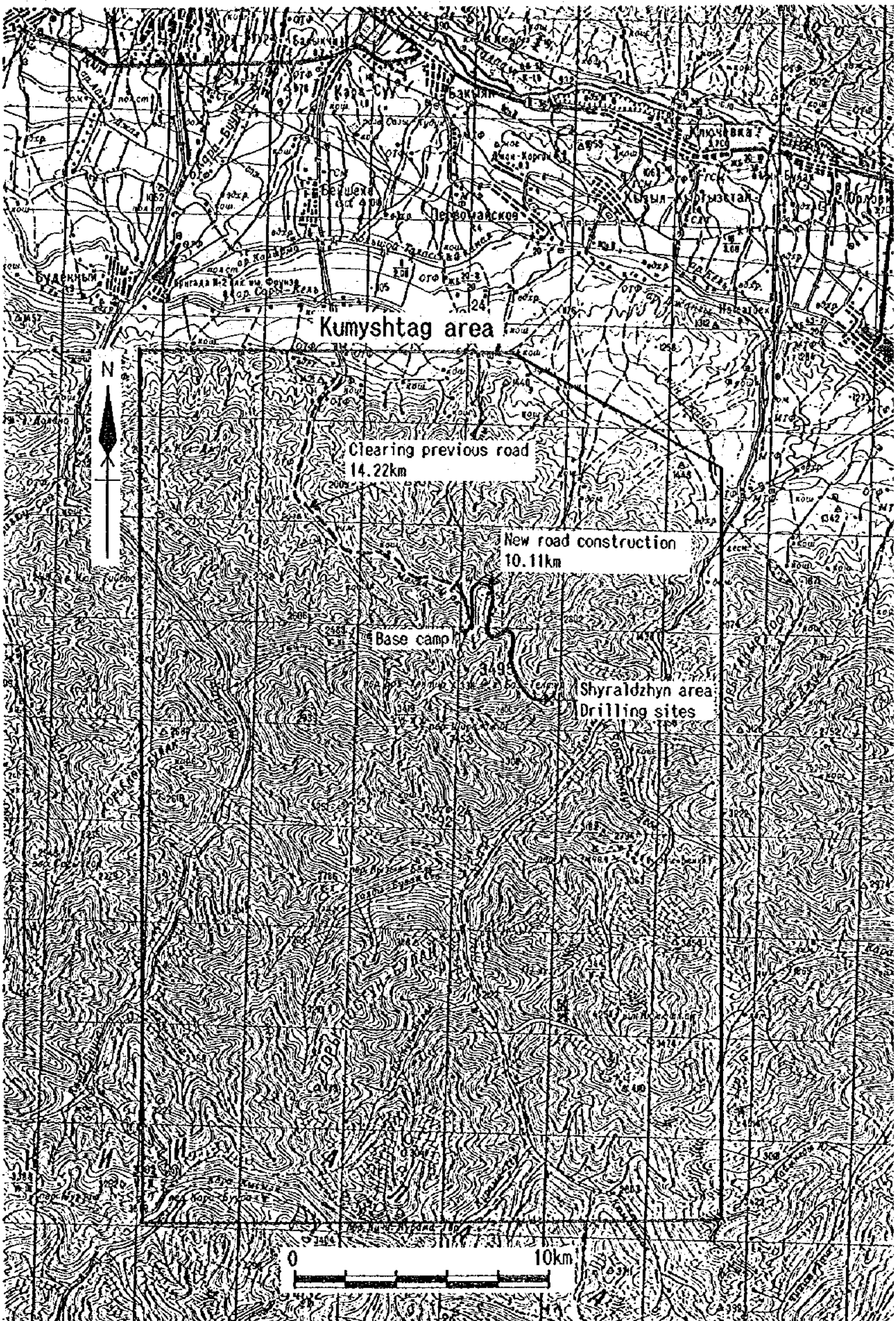


Fig. II-3-1 Location Map of Transporting Road for Drilling Sites in the Shyraldzhyn Area

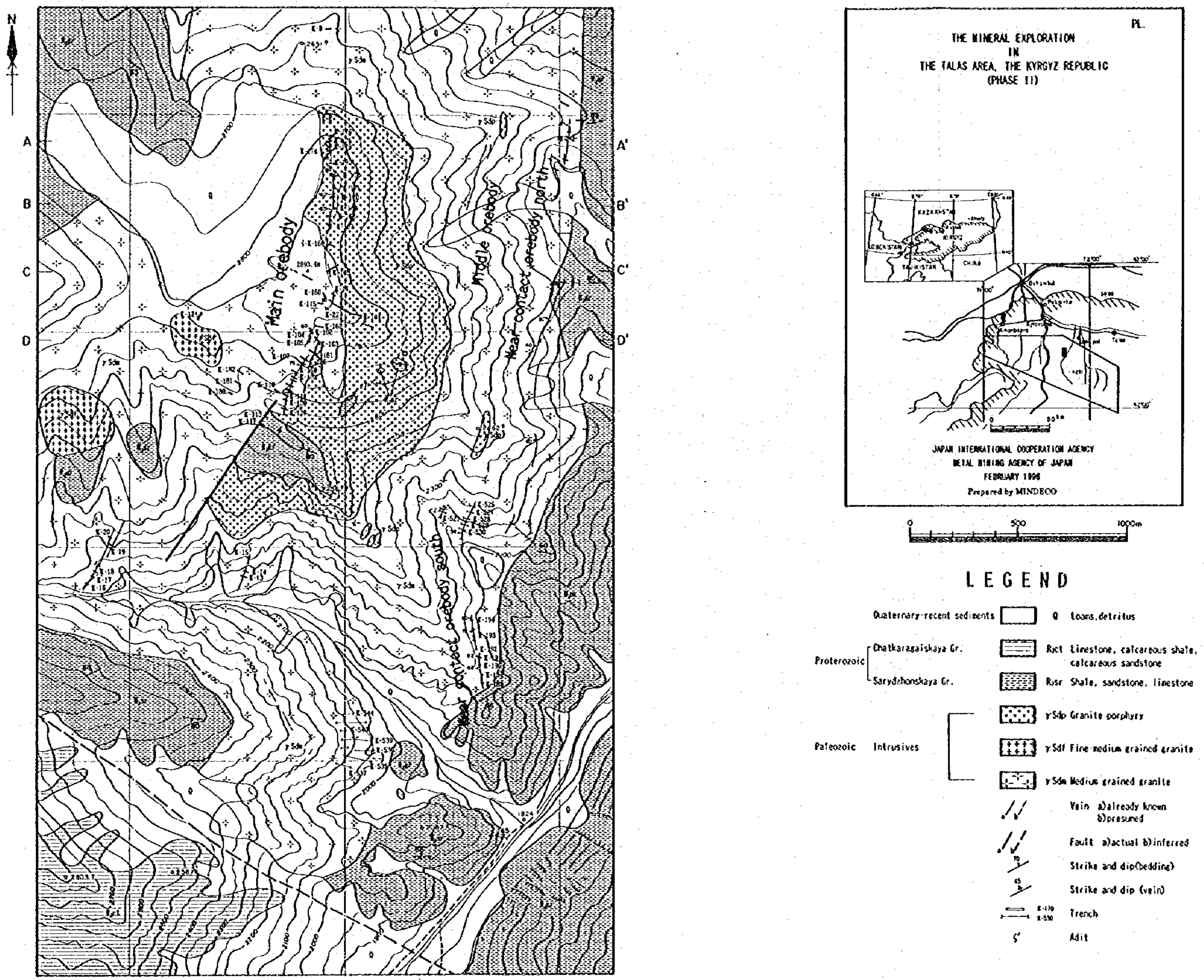
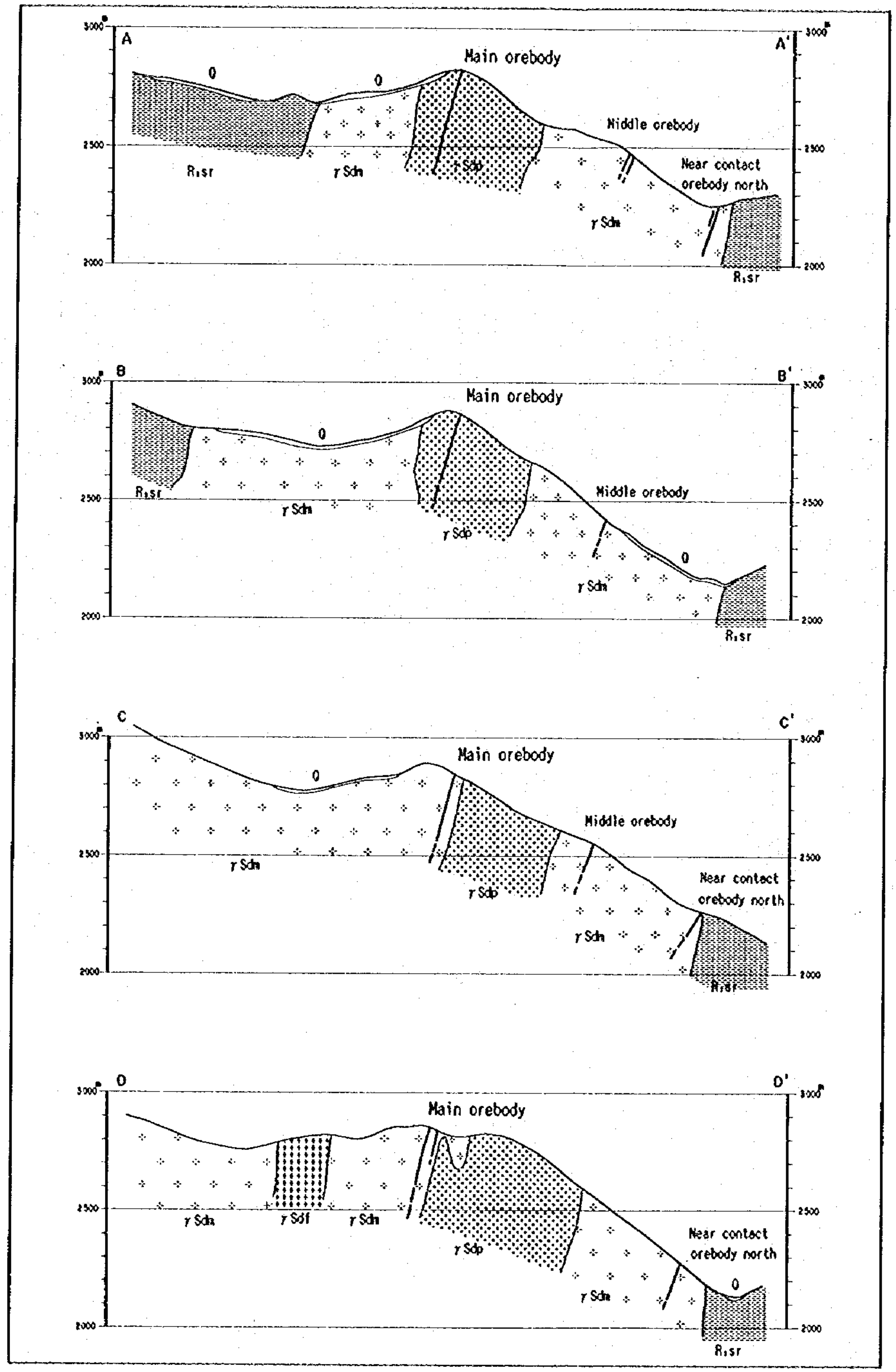
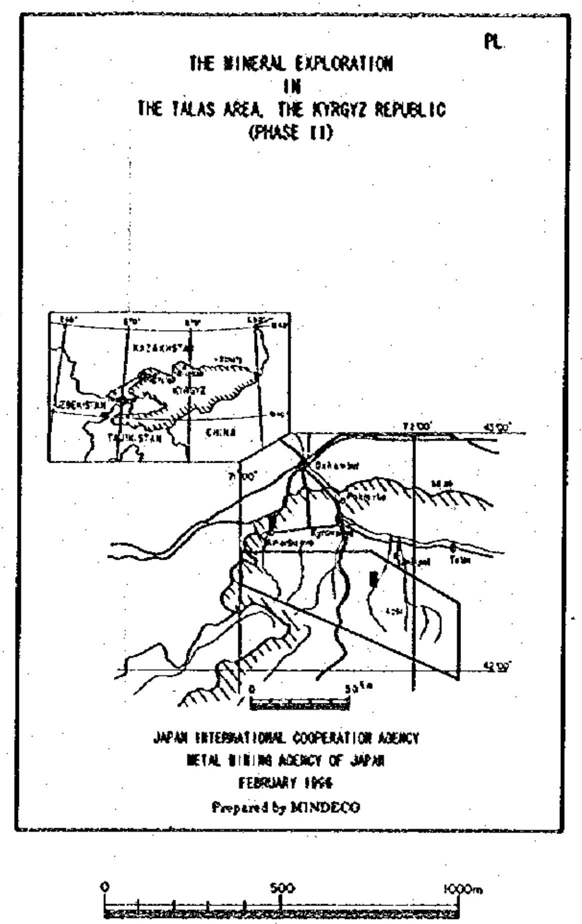


Fig. II-3-2 Geological Map of the Shyraldzhyn Area





LEGEND

Quaternary-recent sediments	Q	Loams, detritus
Proterozoic Sarydzhonskaya Gr.	R₁sr	Shale, sandstone, limestone
Paleozoic Intrusives	γSdp	Granite porphyry
	γSdf	Fine-medium grained granite
	γSdm	Medium grained granite
	a / b	Vein a) already known b) presumed

Fig. II-3-3 Geological Profile of the Shyraldzhyn Area

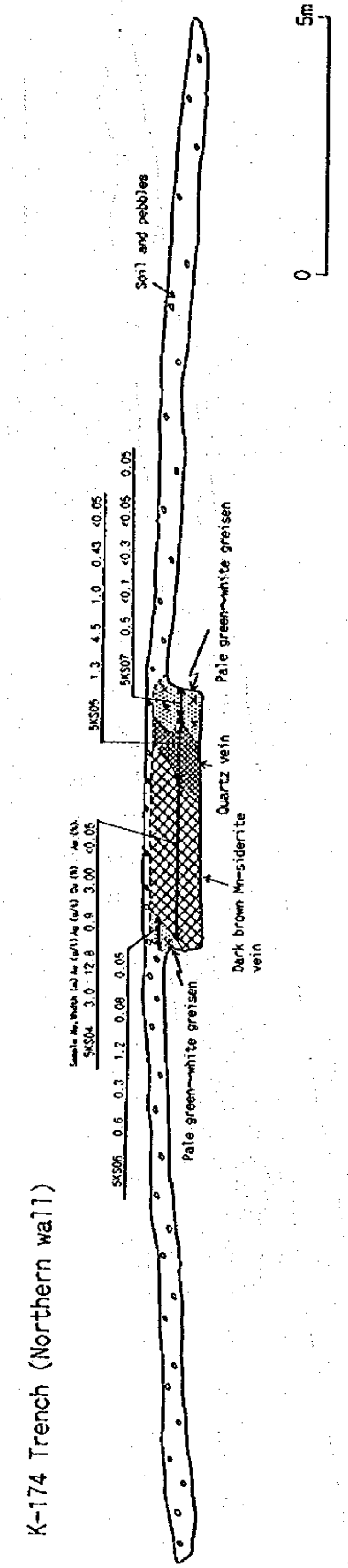


Fig. II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (1)

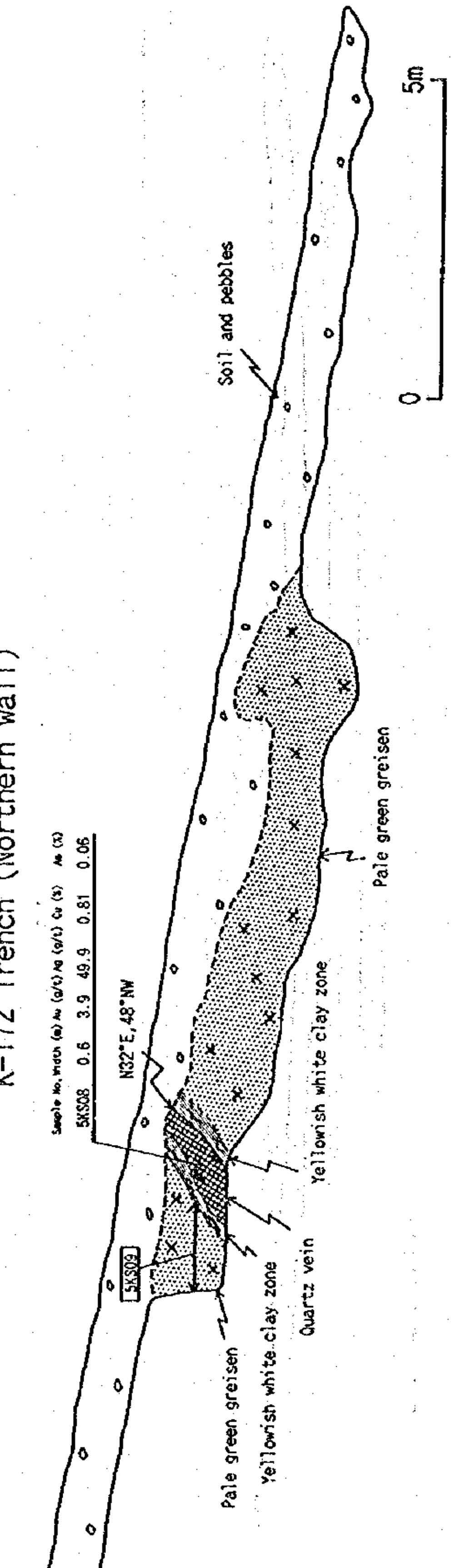


Fig.II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (2)

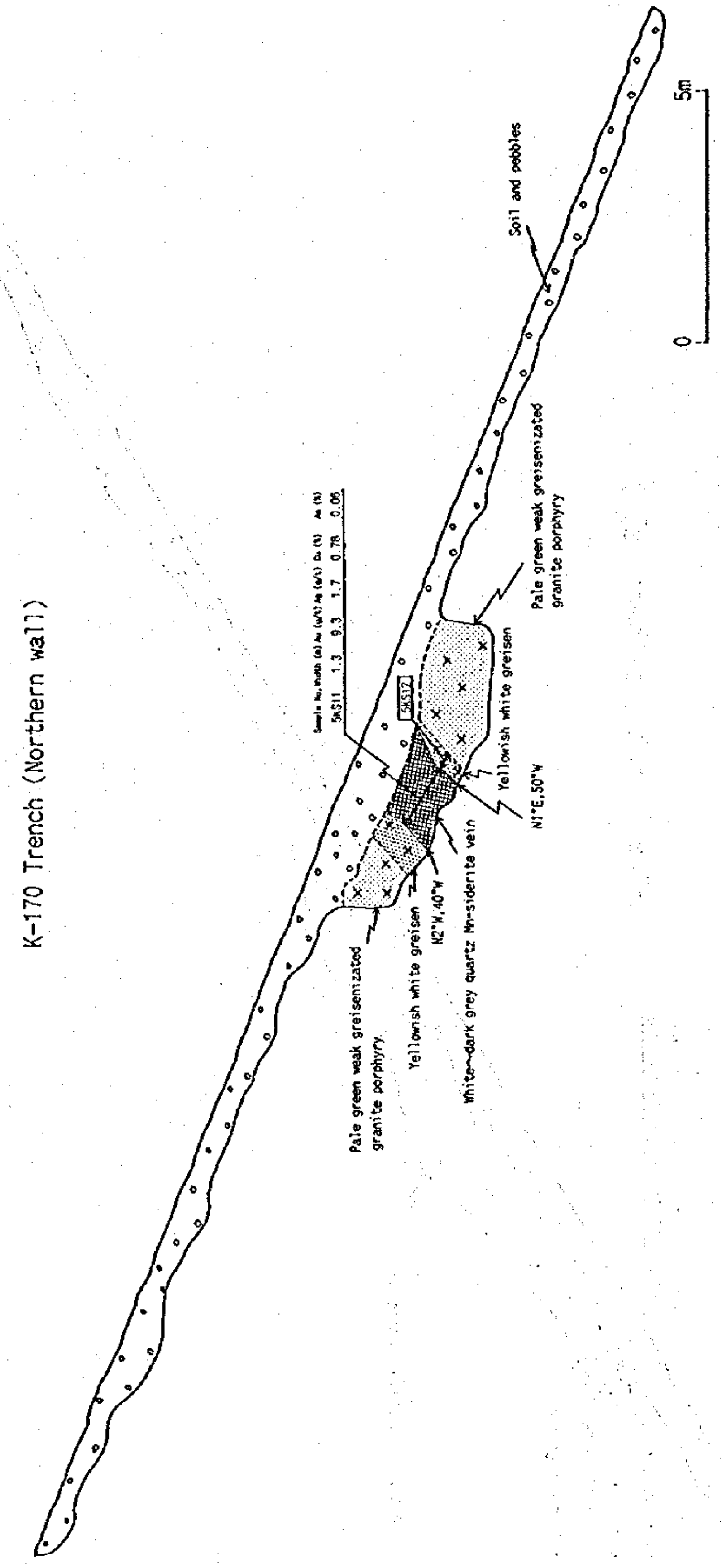


Fig. II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (3)

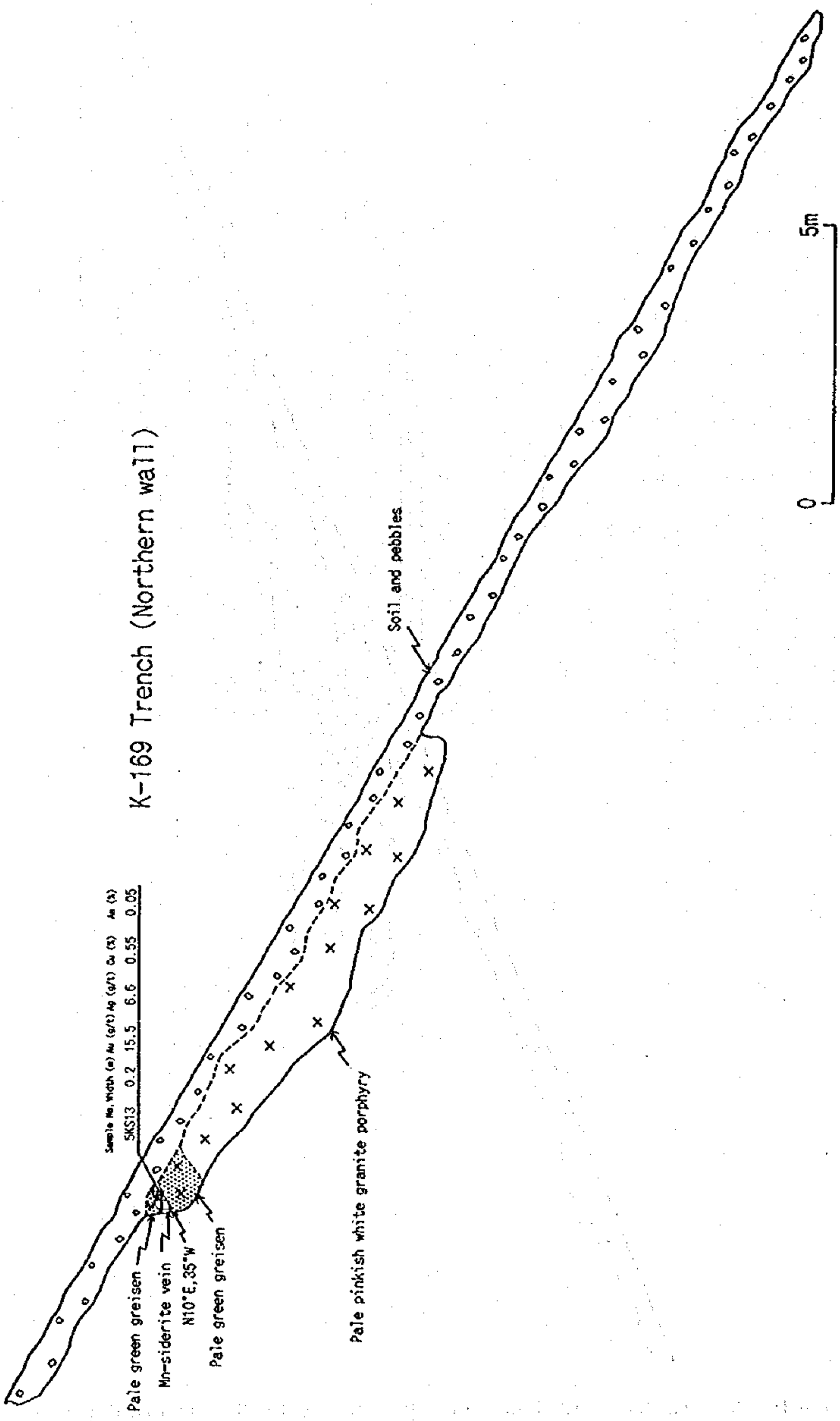


Fig. II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (4)

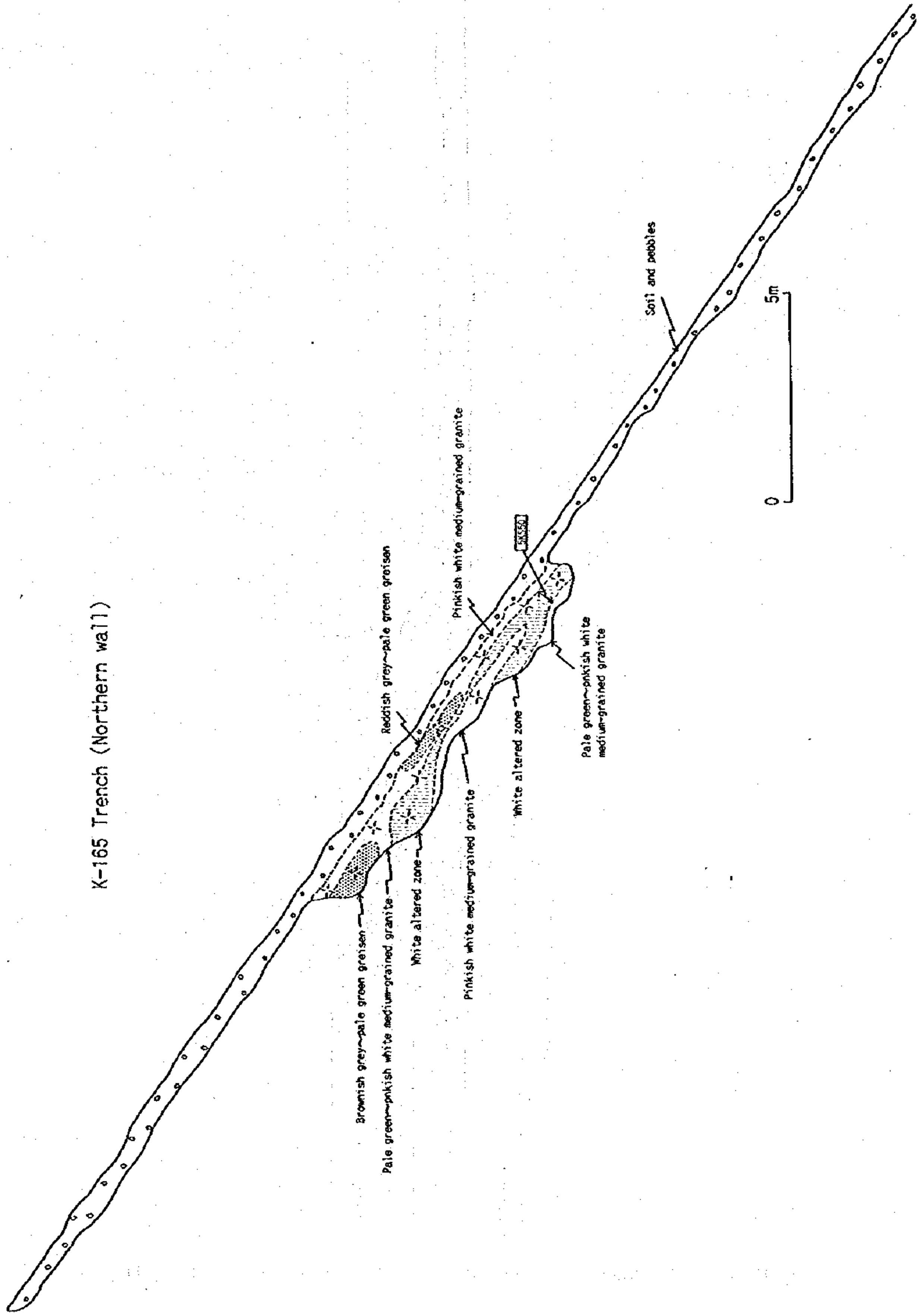


Fig. II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (5)

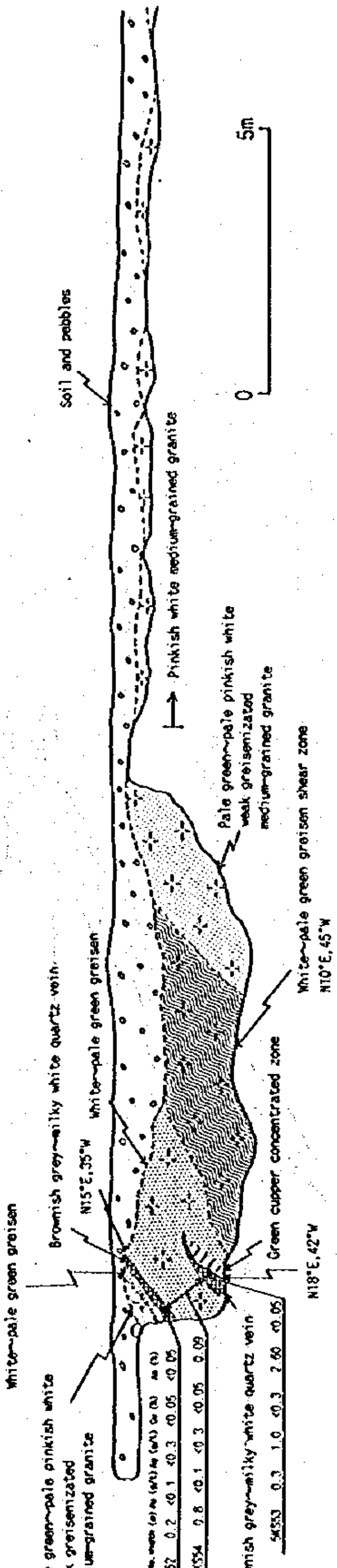


Fig. II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (6)

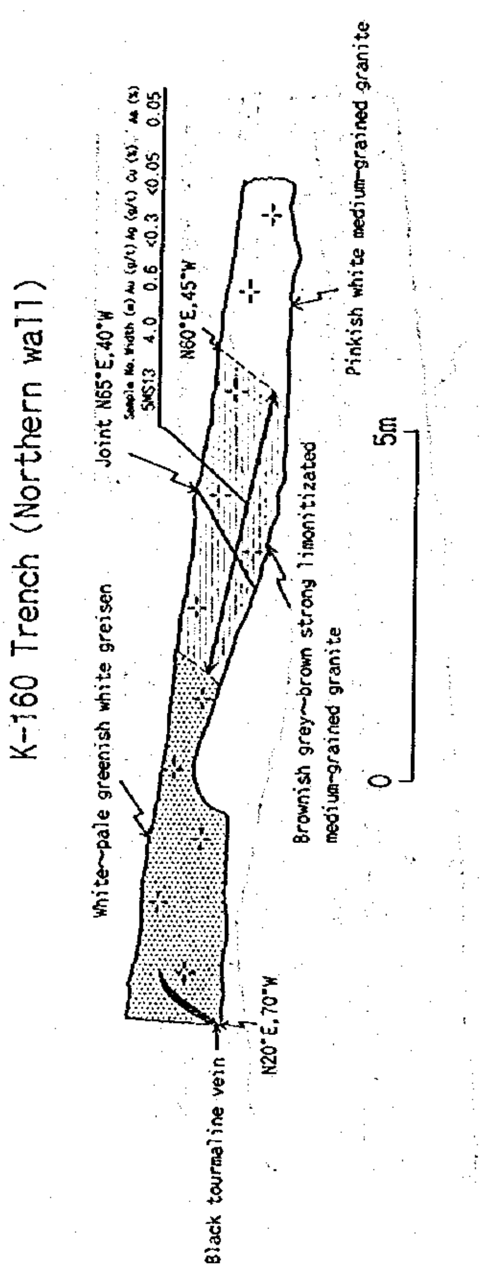


Fig. II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (7)

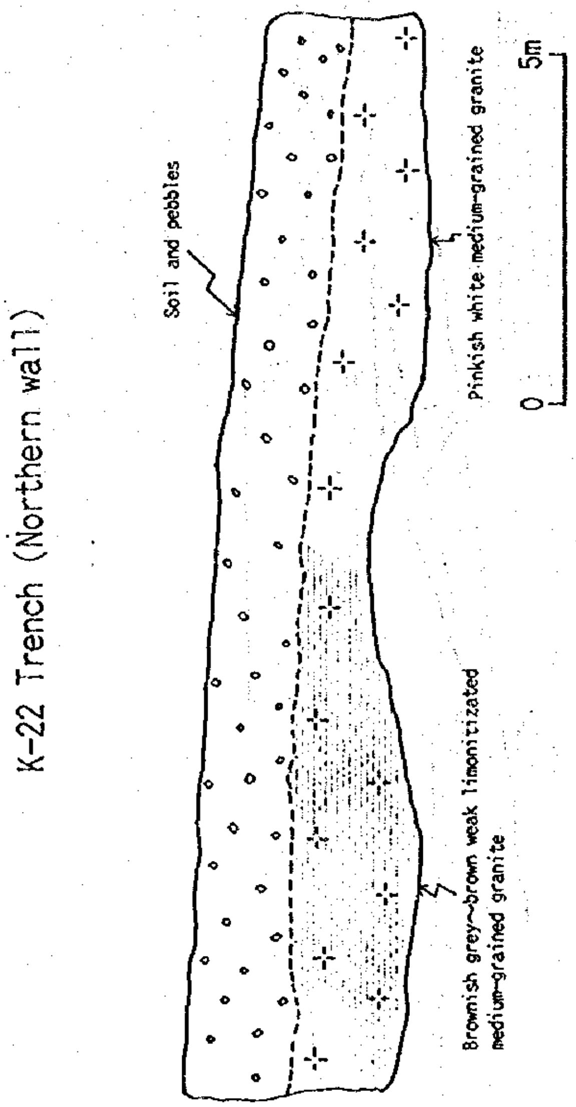


Fig. II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (8)

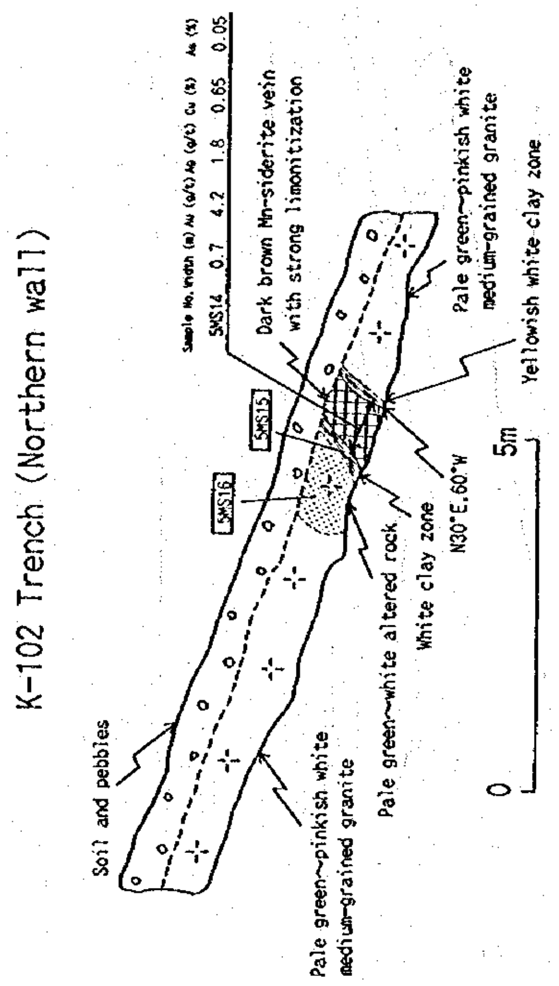


Fig. II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (9)

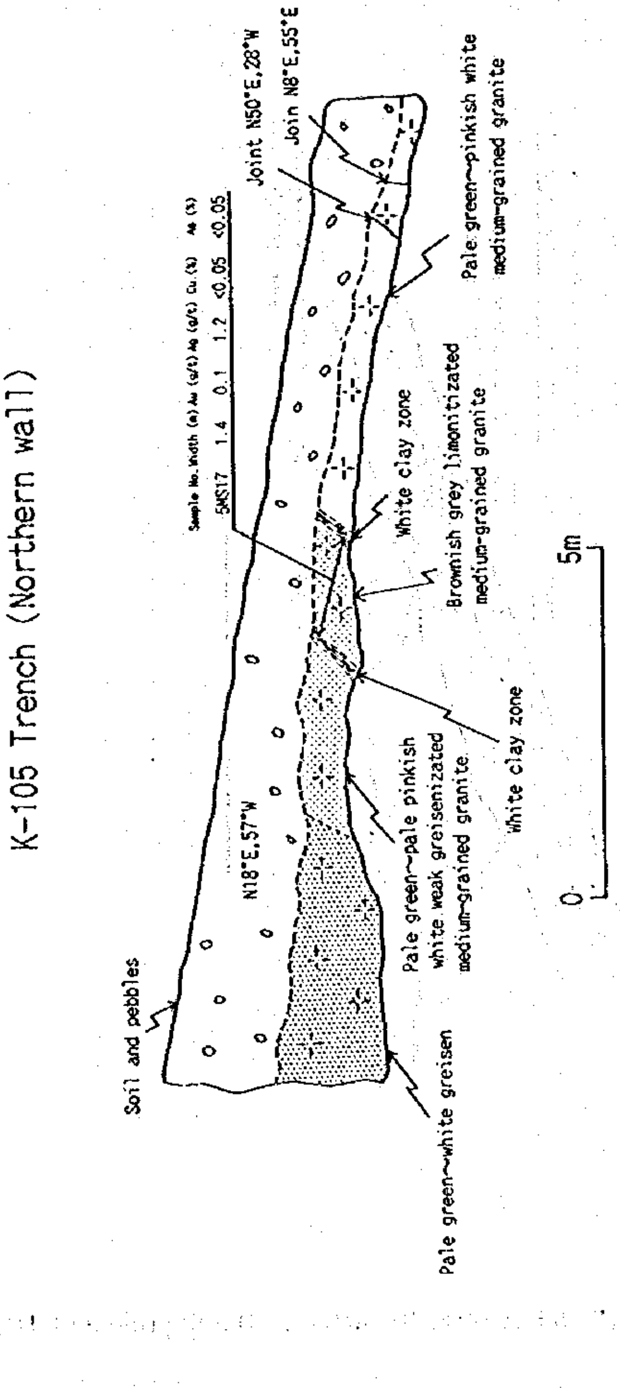


Fig.II-3-4 Geological Sketches of the Trenches in the Shyraldzhyn Deposit (10)

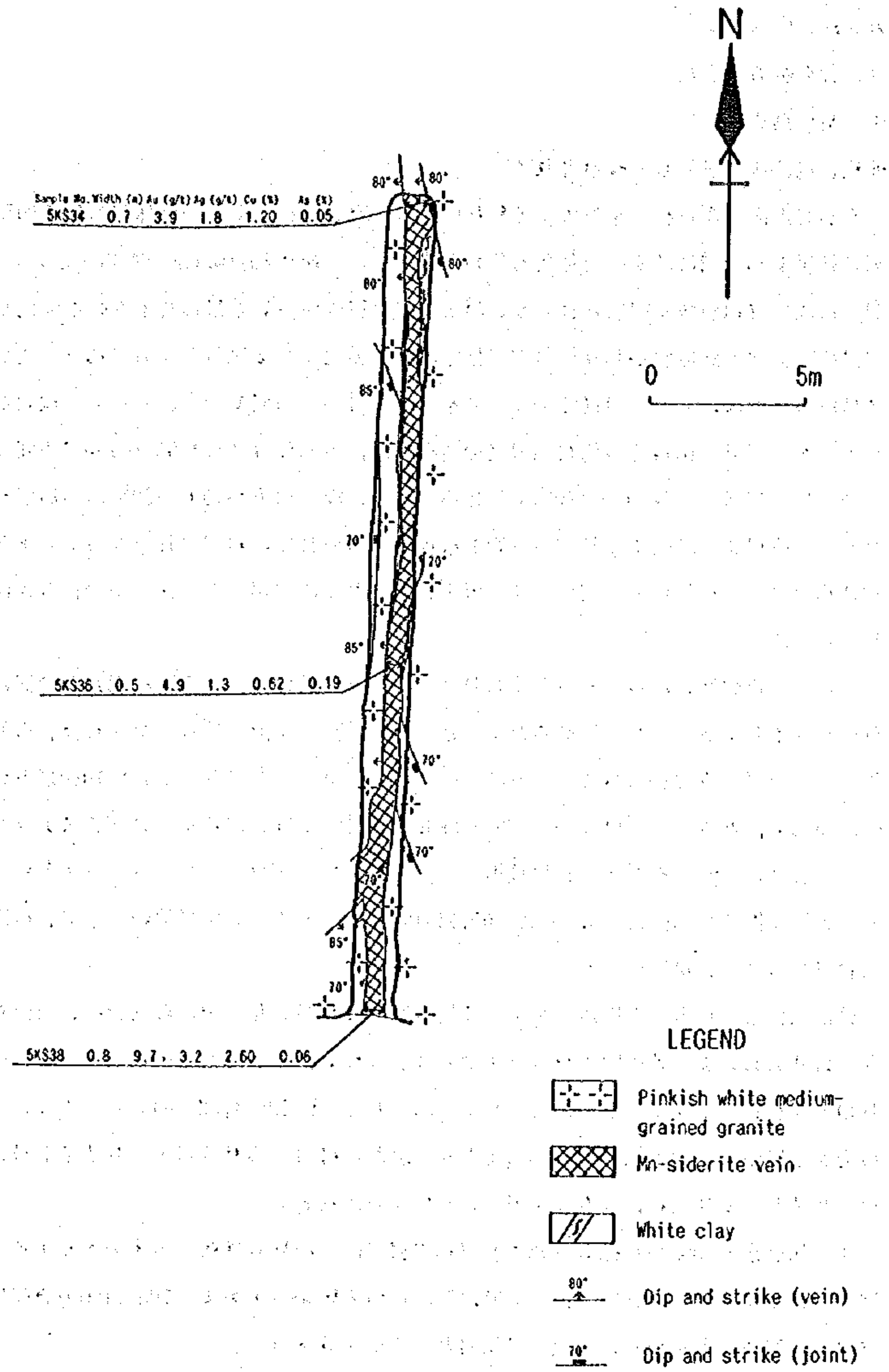


Fig.II-3-5 Geological Sketch of the Adit in the Shyraldzhyn Deposit

ある。なお，砒素は最高品位 0.42%を示したが，As 0.1%未満の鉱石・鉱微部が多い。このように，本鉱床は金鉱化作用が卓越する鉱化帯である。

鉱石は鏡下(Apx.-4)では，褐鉄鉱，軟マンガン鉱，クリプトメレーン鉱を主とし，硬マンガン鉱，含水フランクリン石などのマンガン酸化物・マンガン水酸化物，黄鉄鉱，黄銅鉱並びに黄銅鉱の二次鉱物である孔雀石，藍銅鉱が観察される。金は自然金として石英・黄銅鉱中，時に褐鉄鉱中に，0.003mmから0.015mmの粒径で，自形五角形・十二角形結晶，または長伸状，点滴状粒子として観察される。

本調査地区の含石英・マンガン菱鉄鉱脈から採取した，石英中の流体包有物の均質化温度測定結果をApx.-8に示す。流体包有物の大きさは，一般に20μm以下で非常小さい。産状から擬二次成包有物が多く観察されたが，出来るだけ初成包有物と思われるものを測定した。母結晶の石英は主鉱体脈から４試料が，接触鉱体南部脈から２試料が採取された。測定された６試料の温度は，310℃～120℃の範囲にあるが，210℃～130℃の間に集中する傾向が認められる。また個々の試料での均質化温度の平均値は，主鉱体脈では180℃～150℃の間に集中し，接触鉱体南部脈では220℃～180℃の間に集中して，後者の方が40℃～30℃高い温度を示した。なお，沸騰現象を証明する気相包有物と液相包有物の共存は観察されなかった。また，鉱脈及び花崗斑岩，花崗岩の石英中には，塩化ナトリウムの結晶などを含む多相包有物は観察されなかった。

本鉱床の特徴は，母岩である花崗岩類とマンガン菱鉄鉱鉱脈（含石英脈）との間に，幅1～5mのグライゼンが普遍的に認められることである。グライゼンは肉眼では石英，白雲母を主体とし，源岩の等粒状組織をしばしば残存する。時々，グライゼン中に幅10cm以下の電気石細脈が認められる。鏡下(Apx.-2;5KS07,5KS09,5KS19)では，鱗状グラノブラスチック組織を示し，石英，白雲母を主とし，炭酸塩鉱物，ジルコン，スフェーン，トーライトが認められる。Ｘ線回折分析(Apx.-9;5KS07,5KS09,5KS19)では，その他に少量鉱物として，母岩の残存鉱物である斜長石が認められる。

顕微鏡観察から本鉱床周辺の母岩には斜長石のカリ長石化が認められ(Apx.-2;5KS40,5KS41,5KS42)，またＸ線回折分析結果からは脈ぎわで採取された白色粘土化変質岩には，多量のカリ長石とセリサイトが認められた(Apx.-9,5KS50,5MS11,5MS16)。このように，本鉱床の変質作用の水平的帯状分布は明瞭であり，脈から母岩にカリ長石・セリサイト帯，石英・セリサイト・カリ長石帯（グライゼン帯）に区分される。

主鉱体脈東方300mから採取された変質花崗岩には，酸性変質帯を示すカオリナイトがＸ線回折分析により確認された(Apx.-9;5KS43)。この変質帯はおおよそ10m×10mの範囲に及び，肉眼では淡黄白色を呈し，非変質花崗岩と明瞭に区分される。

主鉱体脈北部に露出する脈ぎわのグライゼンから採取された，白雲母のK-Ar法による絶対年代は，412± 21Maと397±20Maを示し(Apx.-10)，平均は405±21Maとなり，シルル紀末期(S_3)～デボン紀初期(D_1)に相当する。この結果は前述したクムイシュタッグ花崗岩類のU-Pb法による絶対年代の測定結果406±14Maとほぼ同じである。このことは，シュラルジン鉱床におけるグライゼン化作用を含めた一連の鉱化作用が，母岩のクムイシュタッグ花崗岩類の形成末期に生成されたことを示している。

3－4 考 察

本調査地区はリーフェイ系サルジョン層群，チャトガラガイ層群のホルンフェルス，頁岩が分布し，シルル紀末期～デボン紀初期のクムイシュタッグ花崗岩類が貫入する。

シラルジン金鉱床はクムイシュタッグ花崗岩類中に胚胎するマンガン菱鉄鉱脈・石英脈であり，４つの鉱脈からなる。鉱脈の一般走向は北北東－南南西系であり，また花崗岩類中に発達する節理は南北系が多い。このことから，鉱脈の胚胎場の発生は花崗岩体貫入冷却過程中に発達した，剪断節理の形成機構と関連があると推定される。

鉱脈の傾斜は，主脈の尾根上の露頭では35°～48°西落ちの緩傾斜であるが，南方延長部の斜面上では75°と高角度を示す。一方，鉱脈の三次元的分布位置から判断すると真の傾斜は，70°～80°の高角度であると推定される。尾根上での脈の傾斜が緩傾斜であることは，地形的頂部がクリープ現象により下方（東方）にずれ落ちたため変形したものと考えられる。

鉱石分析の結果からシラルジン鉱脈の金：銀比を概観すれば，(2～5)：１で金品位が高く，本鉱床が金優勢な鉱化作用であることを表わしている。また，鉱脈の地表露頭部では褐鉄鉱や孔雀石・藍銅鉱などの酸化銅鉱がしばしば観察されることから，地表部は上部の酸化帯に位置すると考えられる。鉱脈下部の地下水面付近では，断裂系を上昇する高温還元的な鉱化熱水と低温酸化的な地下水との混合が起こり，温度，pH，酸化還元状態が変化し，金の沈殿により経済的な金鉱床が生成する(Hedenquist and Henley, 1984)。シラルジン鉱床付近で最も近い湧水地点は尾根絶頂から北西約１kmに位置し，その標高は2,600mである。これを基に鉱脈下部での地下水面を予想すれば2,700m～2,600mと解釈される。

熱水から金が沈殿する最適温度は個々の鉱床によって異なるが，一般に経済的な鉱脈型金鉱床の流体包有物の均質化温度は，300℃～200℃の範囲であることが知られている(Roedder, 1984)。シラルジン鉱床地表部から採取した石英の均質化温度の平均値は，主鉱体脈では180℃～150℃の間に集中し，接触鉱体南部脈では220℃～180℃の間に集中して，後者の方が40℃～30℃高い温度を示した。主鉱体脈から採取した試料の位置は標高2,850mで，一方接触鉱体

南部脈の位置は標高2,150mであり，比高は700mに及ぶ。一般に流体包有物の均質化温度は，鉱体の下部または中央部で高くなることが知られている。本地区の鉱脈群の産状等から判断すると，これらの鉱脈は同時期に同種の鉱化作用によって生成されたとみられる。主鉱体脈と接触鉱体南部脈とは同一脈ではないが，主鉱体脈と接触鉱体南部脈との均質化温度の温度差は，鉱脈が生成したときの熱源からの位置に関係することを示唆していると考えられる。以上のことから，主鉱体脈の地表部の石英の均質化温度の平均値は180℃～150℃の間に集中し，上述の金鉱床胚胎の最適温度より低温を示すため，地表に露出する金鉱脈の下部延長部に良好な金濃集部が賦存すると推定される。

一般に含金石英脈鉱床の変質帯は，斜長石のカリ長石化またはカリ長石とセリサイトの付加で特徴づけられることが知られている。本鉱床は脈ぎわにカリ長石・セリサイトが認めるられることから，本鉱床は良好な金鉱床賦存の条件を備えていると言えよう。

鉱床脈ぎわのグライゼン中の白雲母の絶対年代の結果（K-Ar法）は405±21Maであり，シルル紀末期～デボン紀初期に相当し，クムイシュタッグ花崗岩類の絶対年代の結果（U-Pb法，406±14Ma）と同年代であった。

以上のことから，シュラルジン金鉱床の生成過程は次のように推察される。

クムイシュタッグ花崗岩質マグマが地下深所から急速に地下浅所に上昇すると，マグマの外縁部は急冷され，緻密な岩相の殻が外縁部に形成される。一方，マグマより分離した高温ガス(400℃以上)がマグマ溜り上部に濃集する。マグマから分離した時は化学的平衡関係にあったが，温度が異なるため，この高温ガスは晶出した鉱物と平衡に存在することができず，断層や剪断割れ目等の構造的弱線部を通路として移動放出し，気成作用により割れ目周辺に石英，白雲母からなるグライゼンを形成した。グライゼンの形成に引き続き，金属を濃集した300℃以下の熱水が剪断割れ目を再び通路として上昇し，最適温度・圧力条件下で割れ目を充填し含金鉱脈型鉱床を生成した。

さらにクムイシュタッグ花崗岩類の中で花崗斑岩は，金鉱化作用が優勢な主鉱体脈に近接して分布すること，またカリ長石化，セリサイト化の変質を著しく被り，白色変質していることなどから，金鉱化作用をもたらした関係火成岩は花崗斑岩である可能性が大きい。

第Ⅲ部　結論及び提言

第1章 結 論

本調査地域は北部天山地塊西部に位置し，バイカル期の褶曲を受けた原生代リーフェイ系を基盤岩類とし，ベンド系，古生界及び新生界が不整合に被覆する。調査地域南縁沿いのタラス・フェルガノ断層により北部天山地塊は中部天山地塊と接する。リーフェイ系は，石灰岩などの炭酸塩岩及び千枚岩，砂岩，頁岩などの砕屑岩を主体とするウズンアフマト層群，主に砂岩・頁岩・シルト岩からなるサルジョン層群，砕屑岩を含む炭酸塩岩が卓越するチャトカラガイ層群，並びに赤色，紫色または緑色のシルト岩で特徴づけられるクズィルベル層で構成される。ベンド系は漂礫岩を含む礫岩，砂岩，シルト岩からなり，カンブリア-オルドビス系は石灰岩，ドロマイトが卓越する。

本調査地域にはクムイシュタッグ・バソリス及びババハン・バソリスが貫入する。クムイシュタッグ・バソリスはカリ長石に富んだ桃色中粒花崗岩が卓越し，U-Pb法による絶対年代の測定結果は406±14Maを示し，シルル紀末期～デボン紀初期に相当する。ババハン・バソリスは明灰色～肌色中粒トーナル岩が卓越し，U-Pb法による絶対年代の結果1,050±50Maを示し，リーフェイ中期～リーフェイ後期に相当する。

第1年次に実施した衛星画像のリニアメント解析結果，主要断層であるタラス・フェルガノ断層，ウズンアフマト・クムイシュタッグ衝上断層，ジョルサイ断層は明瞭に判読され，断層と鉱床分布との関連が指摘された。本年次調査の結果からも，リーフェイ系中に鉱脈状に胚胎するクムイシュタッグ銀鉱床やウチムチェック塊状砒素鉱床，並びにジョルサイ銀鉱床は，ウズンアフマト・クムイシュタッグ衝上断層及びジョルサイ断層などの西北西－東南東系，あるいは東西系断層とそれらの副次的断層，並びにその他の地質構造的不連続線と成因的に関連していると解される。

第1年次に実施した衛星画像の変質帯可能域について，クムイシュタッグ川支流タルディブラック川上流でのグランド・ツルース調査の結果，この変質帯可能域はリーフェイ系ウズンアフマト層群中の褐鉄鉱化した黄鉄鉱が卓越する片岩層であり，続成作用に伴う褐鉄鉱化変質帯を反映したものであって，熱水作用に起因する変質帯ではないことが判明した。

クムイシュタッグ鉱床は規模の大きい銀優勢なマンガン菱鉄鉱脈であるが，金鉱化作用は乏しく，地化学探査結果とも一致した。また，クル・バカイル銀鉱床近傍のジョルサイ断層上に地化学銀異常を捉えたが，小規模な異常域であり，周辺の銀鉱床の規模も小さいため，大規模鉱床の可能性は少ないと推定された。

鉱床規模及び品位の観点から判断すると，本調査地域において経済性のある鉱床はシラル

ジン金鉱床である。シラルジン鉱床はクムイシュタッグ花崗岩を母岩とする含金マンガン菱鉄鉱脈・石英脈であり，走向NNE-SSW，傾斜70°～80°Wを示す4鉱脈が平行に配列している。このうち主鉱体脈は脈幅0.6～3.7m，走向延長1,500mで，Au品位 1.0～19.6g/t，平均Au品位8.6g/tである。金：銀比は(2～5)：1の範囲が多く金に富み，金優勢な鉱化作用であることを示している。国家地質地下資源管理委員会は，トレンチ調査の結果，推定鉱量P_1として1,740千トン，Au品位5g/t，金量8.1トン，推定鉱量P_2として金量8トン，合計金量16トン，平均Au品位 5g/tを計上している。地表トレンチから採取された石英脈中の流体包有物の均質化温度の平均値は180℃～150℃の間に集中し，一般的な鉱脈型金鉱床胚胎の最適温度300℃～200℃より低温を示す。このため地表に露出する金鉱脈の下部延長部に良好な金濃集部が賦存すると推定される。また本鉱床には脈ぎわにカリ長石・セリサイトからなる変質帯が一部に認められることから，本鉱床は良好な金鉱床賦存の条件を備えている。更に鉱脈の露頭部では褐鉄鉱や酸化銅鉱がしばしば観察されることから，地表部は鉱脈上部の酸化帯に位置し，下部には初生の還元帯が存在すると推定される。一般に鉱床下部の地下水面付近では，酸化還元状態の変化により金が多く沈殿し，高品位部を形成すると考えられている。本鉱床付近での湧水地点の位置・標高等から考察すると，鉱脈下部での地下水面は標高2,700～2,600m(地表下150～200m)に位置するとみられる。従って，シラルジン下部での今後のボーリング調査の実施により，有望鉱徴部を捕捉する可能性は極めて高いものと判断される。

また金鉱化作用に先立つグライゼン化作用で生成した白雲母のK-Ar法による絶対年代の測定結果は，405±21Maでシルル紀末期～デボン紀初期に相当し，クムイシュタッグ花崗岩類の絶対年代の結果(U-Pb法，406±14Ma)と同年代であった。このため金鉱化作用はシルル紀末期～デボン紀初期に起きた一連の火成活動末期に生じたと推察される。

第２章　第３年次調査への提言

本調査地域において国家地質地下資源管理委員会により捕捉されていたシラルジン金鉱床は，本年次の地質精査の結果，鉱化作用・変質作用の性質，地表部での鉱床規模・品位が確認され，鉱脈下部に高品位部が胚胎する可能性が高いと判断された。このため，鉱脈下部への連続性とその鉱化状況を直接的に確認するためのボーリング調査を実施することが望ましく，鉱化帯の立体的な分布範囲の捕捉に努め，鉱床の鉱量評価を行う必要があろう。

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APPENDICES

APPENDIX. -1

List of Rock and Ore Samples

Apx.-1 List of Rock and Ore Samples (1)

No.	Sample No.	Locality	Rock name	T	P	C	X	D	F	Remarks
1	5KS01	Shyraldzhyn deposit	Mn-siderite vein			○				3.2m K-175
2	5KS02	Shyraldzhyn deposit	Altered granite			○	○			0.5m K-175
3	5KS04	Shyraldzhyn deposit	Mn-siderite vein			○				3.0m K-174
4	5KS05	Shyraldzhyn deposit	Quartz vein			○				1.3m K-174
5	5KS06	Shyraldzhyn deposit	Muscovite-quartz rock			○	○			0.6m K-174
6	5KS07	Shyraldzhyn deposit	Muscovite-quartz rock	○		○	○	○		0.5m K-174
7	5KS08	Shyraldzhyn deposit	Quartz vein		○	○			○	0.6m K-172
8	5KS09	Shyraldzhyn deposit	Muscovite-quartz rock	○			○	○		1.6m K-172
9	5KS11	Shyraldzhyn deposit	Quartz Mn-siderite vein		○	○			○	1.3m K-170
10	5KS12	Shyraldzhyn deposit	Muscovite-quartz rock				○			0.4m K-170
11	5KS13	Shyraldzhyn deposit	Mn-siderite vein			○				0.2m K-169
12	5KS18	Shyraldzhyn deposit	Sheared altered granite			○				0.6m
13	5KS19	Shyraldzhyn deposit	Muscovite-quartz rock	○	○	○	○			6.4m
14	5KS22	Shyraldzhyn deposit	Quartz vein with Mn-siderite			○			○	1.5m K-106
15	5KS23	Shyraldzhyn deposit	Mn-siderite vein			○				2.0m K-106
16	5KS24	Shyraldzhyn deposit	Mn-siderite vein			○				3.7m K-107
17	5KS25	Shyraldzhyn deposit	Mn-siderite vein			○				1.2m K-102
18	5KS27	Shyraldzhyn deposit	Mn-siderite vein		○	○				2.5m
19	5KS28	Shyraldzhyn deposit	Sheared Mn-siderite ore			○				1.1m
20	5KS29	Shyraldzhyn deposit	Sheared granite with muscovite			○				1.0m K-120
21	5KS30	Shyraldzhyn deposit	Sheared quartz vein			○				1.0m K-120
22	5KS31	Shyraldzhyn deposit	Sheared granite			○				1.0m K-120
23	5KS34	Shyraldzhyn deposit	Mn-siderite vein			○				0.7m adit
24	5KS36	Shyraldzhyn deposit	Mn-siderite vein		○	○				0.5m adit
25	5KS38	Shyraldzhyn deposit	Mn-siderite vein			○				0.8m adit
26	5KS39	Shyraldzhyn deposit	Mn-siderite vein		○	○				0.4m
27	5KS40	Shyraldzhyn deposit	Fine-grained granite	○						
28	5KS41	Shyraldzhyn deposit	Medium-grained granite	○						
29	5KS42	Shyraldzhyn deposit	Granite porphyry	○						
30	5KS43	Shyraldzhyn deposit	Altered granite				○			

T:Thin section P:Polished section C:Chemical analysis X:X-ray diffraction analysis

D:Dating F:Homogenization temperature messurement of fluid inclusion

Apx.-1 List of Rock and Ore Samples (2)

No.	Sample No.	Locality	Rock name	T	P	C	X	D	F	Remarks
31	5KS44	Shyraldzhyn deposit	Mn-siderite vein			○				1.2m B-5
32	5KS45	Shyraldzhyn deposit	Mn-siderite vein		○	○				1.0m B-4
33	5KS46	Shyraldzhyn deposit	Mn-siderite vein			○				0.3m B-3
34	5KS48	Shyraldzhyn deposit	Mn-siderite vein		○	○				2.0m B-1
35	5KS50	Shyraldzhyn deposit	White altered rock				○			0.5m K-165
36	5KS52	Shyraldzhyn deposit	Quartz vein			○				0.2m K-101
37	5KS53	Shyraldzhyn deposit	Quartz vein		○	○			○	0.3m K-101
38	5KS54	Shyraldzhyn deposit	Muscovite-quartz rock			○				0.8m K-101
39	5MS01	Shyraldzhyn deposit	Mn-siderite vein with green copper			○				0.7m K-188
40	5MS02	Shyraldzhyn deposit	Altered granite				○			K-188
41	5MS03	Shyraldzhyn deposit	Altered rock				○			adit
42	5MS05	Shyraldzhyn deposit	Quartz Mn-siderite vein			○				0.3m K-190
43	5MS06	Shyraldzhyn deposit	Quartz vein		○	○			○	0.4m K-191
44	5MS08	Shyraldzhyn deposit	Altered rock				○			K-191
45	5MS09	Shyraldzhyn deposit	Mn-siderite vein			○				0.3m
46	5MS10	Shyraldzhyn deposit	Quartz vein with Mn-siderite			○			○	0.3m K-194
47	5MS11	Shyraldzhyn deposit	Clay vein with green copper			○	○			0.3m K-530
48	5MS12	Shyraldzhyn deposit	Mn-siderite vein			○				0.3m K-528
49	5MS13	Shyraldzhyn deposit	Limonitizated granite			○				4.0m K-160
50	5MS14	Shyraldzhyn deposit	Mn-siderite vein			○				0.7m K-102
51	5MS15	Shyraldzhyn deposit	White clay				○			0.3m K-102
52	5MS16	Shyraldzhyn deposit	White altered rock				○			K-102
53	5MS17	Shyraldzhyn deposit	Limonitizated granite			○				1.4m K-105
54	5KK14	Kumyshtag	Limestone/hornfels skarn gossan		○	○				2.0m
55	5KK18	Kumyshtag	Hornfels gossan			○				6.0m
56	5KK21	Kumyshtag	Quartz vein			○				0.1m
57	5KK23	Manka-Bulak	Quartz vein			○				0.1m
58	5KK26	Chetyn	Altered granite				○			
59	5KK29	Chetyn	Medium-grained granite	○						
60	5KK41	Cheten deposit	Granite porphyry	○		○				1.0m

T:Thin section P:Polished section C:Chemical analysis X:X-ray diffraction analysis

D:Dating F:Homogenization temperature messurement of fluid inclusion

Apx.-1 List of Rock and Ore Samples (3)

No.	Sample No.	Locality	Rock name	T	P	C	X	D	F	Remarks
61	5KK54	Uchimcheck deposit	Altered limestone/shale			○	○			1.0m
62	5KK55	Uchimcheck deposit	Arsenopyrite ore		○	○				waste
63	5KK56	Kumyshtag deposit	Arsenopyrite-pyrite ore		○	○				waste
64	5KK57	Kumyshtag deposit	Arsenopyrite ore		○					waste
65	5KK60	Uzuntashty deposit	Quartz vein			○				0.8m
66	5KK62	Uzuntashty deposit	Vesuvianite-pyroxene-garnet skarn	○						pit
67	5KK64	Uzuntashty deposit	Magnetite ore		○					pit
68	5KK65	Uzuntashty deposit	Fluorite vein			○	○		○	0.8m pit
69	5KK66	Uzuntashty	Quartz vein			○				15.0m
70	5KK68	Shyraldzhyn	Aplite vein				○			
71	5MK02	Taldybulak	Sandstone schist	○						
72	5YK02	Tuktuarcha deposit	Quartz vein		○	○			○	0.3m adit
73	5YK03	Tuktuarcha deposit	Quartz vein			○				0.2m adit
74	5KB05	Babahan	Medium-grained tonalite	○						
75	5KB16	Kuru-Bakair deposit	Manganese gossan		○	○				2.0m
76	5KB18	Kuru-Bakair deposit	Altered shale				○			
77	5KB19	Kuru-Bakair deposit	Quartz vein			○				0.3m
78	5KB20	Babahan deposit	Quartz vein			○			○	0.1m adit
79	5KB24	Babahan deposit	Sphalerite ore		○					waste
80	5KB25	Dzholsay deposit	Mn-siderite vein		○	○				0.7m
81	5KB26	Dzholsay deposit	Mn-siderite vein			○				1.5m
82	5KB27	Dzholsay deposit	Altered shale/sandstone				○			
83	5KB28	Dzholsay deposit	Mn-siderite ore		○	○			○	waste
84	5YB04	Stock deposit	Quartz vein						○	

T:Thin section P:Polished section C:Chemical analysis X:X-ray diffraction analysis

D:Dating F:Homogenization temperature messurement of fluid inclusion

APPENDIX. -2

Result of Microscopic Observations of Thin Sections

Apx.-2 Result of Microscopic Observation of Thin Sections

No.	Sample No.	Locality	Rock name	Primary minerals: Quartz	Plagioclase	K-feldspar	Biotite	Muscovite	Amphibole	Tourmaline	Apatite	Zircon	Sphene	Fluorite	Secondary minerals: Quartz	Albite	Muscovite	Diopside	Garnet	Epidote	Amphibole	Scapolite	Chlorite	Fluorite	Vesuvianite	Calcite	Malachite	Azurite	Thorite	Magnetite	Pyrite	Limonite
1	5KS07	Shyraldzhyn deposit	Muscovite-quartz rock (Greisen)				(△)					·	·		◎		○							·		△			·	·	·	
2	5KS09	Shyraldzhyn deposit	Muscovite-quartz rock (Greisen)				(△)					·	·		◎		○										·	·	△			
3	5KS19	Shyraldzhyn deposit	Muscovite-quartz rock (Greisen)				·					·	·		◎		○										·	·	·			·
4	5KS40	Shyraldzhyn deposit	Fine-grained granite	◎	○	○					·	·					·															
5	5KS41	Shyraldzhyn deposit	Medium-grained granite	◎	△	○	△	·		·	·	·					·						·									
6	5KS42	Shyraldzhyn deposit	Granite porphyry	○	○	○	△	·			·	·	·				·															
7	5KK29	Chetyn	Medium-grained granite	○	○	○	△				·	·		·			·						·									
8	5KK41	Cheten deposit	Granite porphyry	○	○	○	△				·	·																				
9	5KK62	Uzuntashty deposit	Vesuvianite-pyroxene-garnet skarn												·	·		○	○	○	△	·		△	△	△						
10	5MK02	Taldybulak	Sandstone schist	◎	○	○				·		·					△						△			△						
11	5KB05	Babahan	Medium-grained tonalite	○	◎	△	△		·		·	·	·				·			·												

◎:Abundant(+50%) ○:Common(50-20%) △:Poor(20-5%) ·:Rare(-5%) ( ):Pseudomorph

Description of Microscopic Observation of Thin Section

1. THIN SECTION 5KS07

Rock name: Muscovite - quartz rock (Greisen).
Structure: Lepidogranoblastic, glomeroblastic.
Texture: Massive, mottled.
Composition: Quartz 55-60%, muscovite 30-35%, carbonate 5%, ore minerals pyrite, magnetite) 1-2%, fluorite - isolated signs, zircon - isolated signs, thorite - isolated sings.

The rock consists of quartz and muscovite in considerable amounts. Quartz is observed in a shape of grains of irregular, equidimensional form, with meandering, sometimes polygonal boundaries. Quartz marks up lenticular accumulations, veinlets. Grain sizes are within 0.3 mm 1.0 mm. Quartz contains inclusions of muscovite and ore minerals scales.

Muscovite is represented by isolated scales of 0.3 mm - 5.0 mm size. These scales are pseudomorphs over biotite of the primary rock. The bulk of muscovite forms accumulations of gray-yellowish scales in the rock, which are of random orientation, sometimes crowding in rosettes. These aggregates appear to have substituted for feldspathose grains of the primary rock. Hightened hydrous ferric oxide content is confined to the same areas making them rusty-brown colored, which determines mottled texture of the sample.

Carbonate occurs in a shape of isolated grains and insignificant concentrations among quartz-muscovite aggregates.

Fluorite is found as fine monometric violet-colored grains of 0.02 mm - 0.03 mm size, which are confined to muscovite aggregate.

Accessory minerals: zircon, sphene, thorite, observed as fine (0.03 mm - 0.05 mm) idiomorphic grains in muscovite and quartz.

2. THIN SECTION 5KS09

Rock name: Muscovite - quartz rock (Greisen).
Structure: Lepidogranoblastic, glomeroblastic, sutured.
Texture: Massive, mottled.
Composition: Quartz 55-60%, muscovite 40%, ore minerals - isolated signs, zircon - isolated signs, sphene - isolated signs, malachite, azurite 1-2%.

The rock consists of more or less equidimensional quartz grains of 0.2 mm - 2.0 mm size, observed as both isolated grains and accumulations.

Coalescence border-lines are straight and flexuous. Quartz grains contain inclusions of fine scales of muscovite and ore minerals. Muscovite makes up near-monomineral glomeroblastic accumulations of fine grains in the rock which are of random orientation, rarely grouping in rosettes. Sizes of scales composing these areas vary from 0.02 mm to 0.2 mm. Besides those, there are isolated muscovite scales of up 1.0 mm size observed in the rock, which are pseudomorphs over biotite of the primary rock. Ore mineral (magnetite, hematite) is distinct at the cleavage planes. Muscovite color is gray-greenish yellow. Muscovite areas often acquire irregularly mottled, rusty-brown color, owing to limonitized sulphides and other minerals.

Accessory minerals are represented by thorite, sphene, zircon in a shape of idiomorphic grains of 0.05 mm -0.15 mm size. Among quartz-muscovite aggregates, thin-aggregated 0.1 mm - 0.5 mm separations, with rugged margins and permeative boundaries of green, blue color are found; those are malachite and azurite.

3. THIN SECTION 5KS19

Rock name: Muscovite - quartz rock (Greisen).
Structure:. Glomeroblastic, lepidogranoblastic, sutured.
Texture: Massive, mottled.
Composition: Quartz 55-60%, muscovite 35-40%, malachite, azurite 1%, limonite 1%, biotite - isolated signs, thorite, zircon, sphene - isolated grains.

The rock consists of more or less monometric quartz grains with even and castellated facets, of 0.3 mm to 1.5 mm size. Quartz contains numerous muscovite inclusions and isolated biotite ones.

Muscovite is observed as separate scales, pseudomorphically replacing biotite and accompanied by ore mineral show at cleavage planes, and also forms accumulations of fine grains of random orientation in the rock. These accumulations have rectangular outlines, which may be indicative of their replacement of feldspars. Hightened hydrous ferric oxide content is confined to these areas, giving them rusty-brown color and causing the mottled texture of the rock.

Accessory minerals are represented by fine (0.05 mm - 0.1 mm) idiomorphic grains of thorite, zircon, sphene, which are confined to biotite, muscovite. Pleochroic haloes are observed around thorite in biotite. At the background of quartz-muscovite aggregates, various fine (0.1 mm - 0.5 mm) blue and green colored areas composed by malachite and azurite are distinguished.

4. THIN SECTION 5KS40

Rock name: Fine-grained granite.
Megascopic description: Pink-colored dense rock.
Structure: Hypidiomorphic-grained, poikilitic.
Texture: Massive
Composition: Microline 40%, quartz 30-35%, plagioclase 20-25%, sericite + muscovite app. 1%, zircon - isolated signs, apatite - isolated signs, ore mineral - isolated sign.

Common potash feldspar is represented by microcline, chesterlite in a shape of tabular grains of pink, meat-like red color, of 0.5 mm - 2.0 mm size. It forms coalescence with all minerals of the rock. The coalescence boundaries are straight, step-like, flexuous. Potash feldspar is strongly corroded by quartz, albite.

Plagioclase are represented by oligoclase and albite in a shape of elongated-prismatic grains of 0.2 mm - 1.0 mm size. Metasomatic albite has a wide-spread occurrence, being developed over potash feldspar, substituting for it as spots, strips, up to formation of the complete pseudomorphs.

These are two kinds of quartz: magmatic quartz has a xenomorphic shape of 0.3 mm - 1.0 mm size, corroding the minerals separated earlier; metasomatic quartz occurs as isolated grains, nests in the rock, of up to 3.0 mm size. It contains numerous inclusions of microline and other minerals.

Muscovite, sericite are developed in a shape of small accumulations at the boundary of quartz and feldspar.

Accessory minerals are represented by zircon, apatite fine (0.05 mm - 0.1 mm) idiomorphic grains, found in quartz.

5. THIN SECTION 5KS41

Rock name: Medium-grained granite.

Megascopic description: Pink-colored dense holocrystalline rock.

Structure: Hypidiomorphic-grained, poikilitic.

Texture: Massive

Composition: Quartz app. 35%, microcline app. 40%, plagioclase app. 20%, biotite app. 5%, muscovite, sericite, apatite, zircon, ore minerals, chlorite, tourmaline.

Common potash feldspars are represented by chesterlite and microcline in a shape of irregular tabular grains of 1.0 mm - 3.0 mm size. Potash feldspar is intensively pelitized and albitized. Strong pelitization is irregularly distributed in a shape of spots and strips. Chesterlite and microcline grains are of pink, meat-like red, brown color. Potash feldspars contains biotite, muscovite, ore mineral inclusions.

Plagioclase are represented by two varieties: oligoclase and albite in a shape of elongated-prismatic grains of 0.5 mm - 2.0 mm size. Oligoclase is insignificantly pelitized, sericitized. Sericite is observed in a range from isolated scales to the considerable amounts. Metasomatic albite is abundant in the sample, being confined mainly to microcline as numerous replacement perthites, rims of potash-feldspathose grains.

Quartz is represented by xenomorphic grains of 0.5 mm - 3.0 mm size, contains inclusions of ore minerals, tourmaline, zircon, muscovite.

Biotite occurs in s shape of idiomorphic brown-colored plates of 0.3 mm - 2.0 mm size, partly substituted at the margins by chlorite. Some scales are replaced by muscovite with intensity from initial stages up to formation of the complete pseudomorphs.

Accessory minerals are fine (0.1 mm - 0.2 mm) idiomorphic grains of apatite, zircon, found in quartz, biotite.

6. THIN SECTION 5KS42

Rock name: Granite porphyry.

Structure: Hypidiomorphic-grained, glomeroporphyric, porphyric.
Texture: Massive.
Composition: Microcline, chesterlite, plagioclase, quartz, biotite, muscovite, sphene, zircon, apatite.

Porphyric separations (10%) are represented by microcline prisms, quartz and also by aggregates of feldspathose grains. Porphyric separation amounts are 2.0 % - 3.0 %.

Rock parenchyma tissue is made up by plagioclase, microcline, quartz, biotite, muscovite. Parenchyma grain sizes are within 0.2 mm - 0.5 mm, in rare cases reaching 1.0 mm.

Common potash feldspar is represented by microcline in a shape of tabular grains with ragged boundaries due to their corrosion by quartz and other minerals.

Potash feldspar is strongly pelitized and albitized. Plagioclase is represented by oligoclase and albite, occurring as prismatic grains replaced by sericite at a variable degree. Metasomatic albite is widespread, being confined to microcline as replacement perthites as well as fringes and rims around potash-feldspathose and oligoclase crystals. Quartz is observed in a shape of xenomorphic grains of 0.2 mm - 0.5 mm size.

Biotite is almost completely substituted by muscovite, with relics remaining as dark-brown inclusions in muscovite, parallel to cleavage planes.

Accessory minerals are represented by fine idiomorphic grains of sphene, zircon, apatite in quartz and biotite.

7. THIN SECTION 5KK29

Rock name: Medium-grained granite.
Megascopic description: Pink-colored dense holocrystalline rock.
Structure: Hypidiomorphic-grained, poikilitic.
Texture: Massive.
Composition: Microcline 40%, plagioclase 20%, quartz 30-35%, biotite 5%, chlorite, sericite, apatite, zircon, fluorite, ore minerals.

Common potash feldspar is represented by microcline and chesterlite in a shape of irregular tabular-formed grained of 1 mm - 5 mm size. It makes up coalescence with all minerals, composing the rock. The coalescence boundaries are straight, step-like, flexuous. Its color is meat-like red, pink because of a considerable pelitization. Potash feldspar contains inclusions of muscovite, quartz, plagioclase, biotite and ore minerals

Plagioclase is represented by oligoclase and albite in a shape of elongated-prismatic grains of 0.3 mm - 2.0 mm size. Their color is white, gray-white. Oligoclase is insignificantly sericitized. Albite is metasomatic, occurring as replacement perthites in microcline and also as isolated grains, rims around potash-feldspathose and oligoclase crystals.

Quartz is represented by xenomorphic grains, often corroding the minerals separated earlier, such as potash feldspar, plagioclase and biotite. Grain sizes are within 0.3 mm - 2.0 mm range.

Biotite is observed as isolated scales of 0.2 mm - 0.5 mm size, being partly substituted by chlorite and muscovite.

There are 0.2 mm - 2.0 mm fluorite grains found in the rock, which occur interstitially between grains of plagioclase, potash feldspar, biotite, and corrode them.

Accessory minerals are represented by fine idiomorphic grains of zircon and apatite, confined to biotite and feldspar.

8. THIN SECTION 5KK41

Rock name: Granite porphyry.

Structure: Porphyric, glomeroporphyric, with hypidiomorphic-grained bulk.

Texture: Massive.

Composition: Microcline, plagioclase, quartz, biotite, zircon, apatite, ore mineral.

Porphyric separations (50%) are represented by quartz, microcline, plagioclase, biotite of 1.5 mm - 2.0 mm size. Quartz has no limitations, contains numerous feldspathose inclusions. Biotite scales contain fine inclusions of feldspar and quartz.

Rock parenchyma tissue (50%) is holocrystalline, consisting of the same minerals as the porphyric separations. Parenchyma grain sizes are 0.1 mm - 0.3 mm.

Plagioclase is the most idiomorphic. Biotite has meandering outlines, due to a significant corrosion by the minerals separated later.

9. THIN SECTION 5KK62

Rock name: Vesuvianite-pyroxene-garnet skarn.

Megascopic description: Brownish-green dense rock. At the background of the fine-grained white-gray parenchyma tissue, spots of 3 mm - 20 mm size, composed by garnet, fluorite, vesuvianite and others, are distinguished.

Structure: Glomeroblastic, nematoblastic, poikiloblastic.

Texture: Mottled

Composition: Garnet, fluorite, vesuvianite, pyroxene, amphibole, epidote, carbonate, feldspar, scapolite, quartz, magnetite.

The rock is a skarn of a complex composition, characterized by a mass development of epidote, amphiboles, chlorite, quartz, fluorite, calcite, additionally to the essential skarn minerals (garnet, pyroxene, vesuvianite and others). Presence of the mineral associations, different in their composition, is indicative of the mineralization having taken place in a wide temperature interval.

Pyroxene is one of the earliest skarn minerals. It occurs in a shape of columnar crystals, sometimes forming sheaf-like aggregates. Grain sizes vary within the range from 0.n mm up to 3.0 mm. Its hue is from achromatic to grayish-green. By the optical constants, it corresponds to diopside. Pyroxene is replaced by the later minerals, such as epidote, calcite, quartz, colorless amphibole. The replacement can be observed in different intensities: from the initial stages at the grain margins and cleavage planes up to formation of the complete pseudomorphs.

Garnet has a wide-spread occurrence in the sample. There are two varieties of it to be marked out. The first is dense fine-grained garnet, with grain size of 0.0n mm to

0.n mm, makes up separations of elliptic, elongated form. The larger well-bounded crystals occur in cavities. Garnet color is brown, anomalous, with sector extinction. The garnet is substituted by later minerals, such as calcite, chlorite, quartz and magnetite.

Vesuvianite occurs in a shape of round-columnar individuals of 1.0 mm - 2.0 mm size and contains numerous inclusions of carbonates, pyroxene, amphibole and epidote. Some vesuvianite grains form close coalescence with garnet, which shows their almost simultaneous formation.

Epidote is abundant in the rock. It has been separating over a long period of time. Only small part of it was separating at the same time as pyroxene, garnet, forming corresponding intergrowth. As to its bulk, it is a product of replacement of garnet, vesuvianite, pyroxene, composing isolated grain accumulations of irregular form and sometimes considerable monomineral aggregates. Epidote is, in its turn, replaced by chlorite, quartz and calcite.

Amphibole is represented by its achromatic variety developed over pyroxene, and also by uralite hornblende with grain sizes of 0.1 mm to 0.3 mm. Amphiboles are partly substituted by chlorite and carbonate.

Fluorite is widespread in the sample (app. 10 %) and is represented by well-bounded crystals of sizes variable within the limits of 0.1 mm - 2.0 mm. Fluorite is colorless or irregularly colored in violet tints. It is found in a shape of isolated grains, small accumulations in vesuvianite, garnet, pyroxene, carbonate. Coalescence border-lines are straight.

Carbonate is of a wide-spread occurrence in the rock. There are areas totally composed by fine-grained calcite, which is a parenchyma tissue for the subsequent development of skarn minerals such as pyroxene, garnet, vesuvianite - relics of the near-contact rocks. Later on, calcite is being formed over a long period of time as a product of replacement of pyroxene, garnet, vesuvianite, epidote, etc. The latest, crystalline calcite fills up cavities and joints in the rock.

Scapolite is found in insignificant quantities (less than 5%). It is observed as tabular crystals with uneven margins, of 1.0 mm - 2.0 mm size. Scapolite is replaced by epidote, calcite, albite; contains fluorite grains.

10. THIN SECTION 5MK02

Rock name: Sandstone schist.

Megascopic description: Gray dense rock with rusty-brown spots.
Spot sizes are 1 mm - 3 mm. Spot form is elliptic, monometric.

Structure: Siltypsammitic, lepidogranoblastic.

Texture: Mottled, foliated, flaser.

Composition: Quartz, common potash feldspar, plagioclase, carbonate, sericite, muscovite, ore minerals, zircon, tourmaline.

The rock is shown being formed in two stage. Primary rock is silty-sandstone. Its detrital part is composed by quartz, common potash feldspar, plagioclase, carbonate, ore mineral, isolated grains of tourmaline, zircon. Grain size in the detrital part makes up 0.05 mm - 0.3 mm. Debris form is angular, monometric, elliptic, tabular, often with ragged margins. Cement type is porous.

As a result of cataclasis, development of foliated texture as well as structure transformation through blastic deformation took place. Owing to the cement and also to the detrital part of the rock, sericite aggregate, grouping in interrupted partings, was formed. Fragmental relics, oriented parallel to foliation of the rock, have remained of the primary minerals (quartz, feldspars, carbonates). Here there, thin fringes of sericite are developed around debris, due to which the texture acquires flaser character.

Rock mottling is caused by the presence of monometric aggregate separations, composed by quartz, feldspars and hydrous ferric oxides.

11. THIN SECTION 5KB05

Rock name: Medium-grained tonalite.

Megascopic description: Light-gray colored dense rock.

Structure: Hypidiomorphic-grained, glomeroblastic.

Texture: Massive.

Composition: Plagioclase 60%, quartz 25%, biotite 10%, common potash feldspar 5%, amphibole 1%, epidote, sericite, zircon, apatite, sphene.

Plagioclase is represented by andesine in a shape of short-prismatic, tabular grains with prevailing size of 1 mm - 2 mm. Plagioclase has a zonal structure. It is slightly replaced by sericite, pelitic matter, with them being irregularly distributed - by growth zones. Fringe-zones are pure, while inner zones are substituted by secondary minerals. Plagioclase makes up coalescence with all rock minerals. Coalescence boundaries are straight, step-like, flexuous.

Quartz occurs as xenomorphic grains, often corroding minerals separated earlier, such as plagioclase, common potash feldspar and biotite. Grain sizes are from 0.2 mm to 2.0 mm. Aggregate accumulations of quartz grains are also met.

Biotite is represented by brown, greenish-brown scales of 0.3 mm - 2.0 mm size. Some biotite scales at the margins and cleavage planes are replaced by epidote.

Common potash feldspar is represented by microcline in a shape of xenomorphic grains located in the interstices between biotite, plagioclase grains. Some potash feldspathose grains become overgrown with a thin rim of 0.1 mm - 0.2 mm thickness, consisting of plagioclase and containing numerous vermicular intergrowth of quartz composition - myrmekite.

Accessory minerals are represented by idiomorphic grains of zircon, apatite, sphene which are confined to biotite.

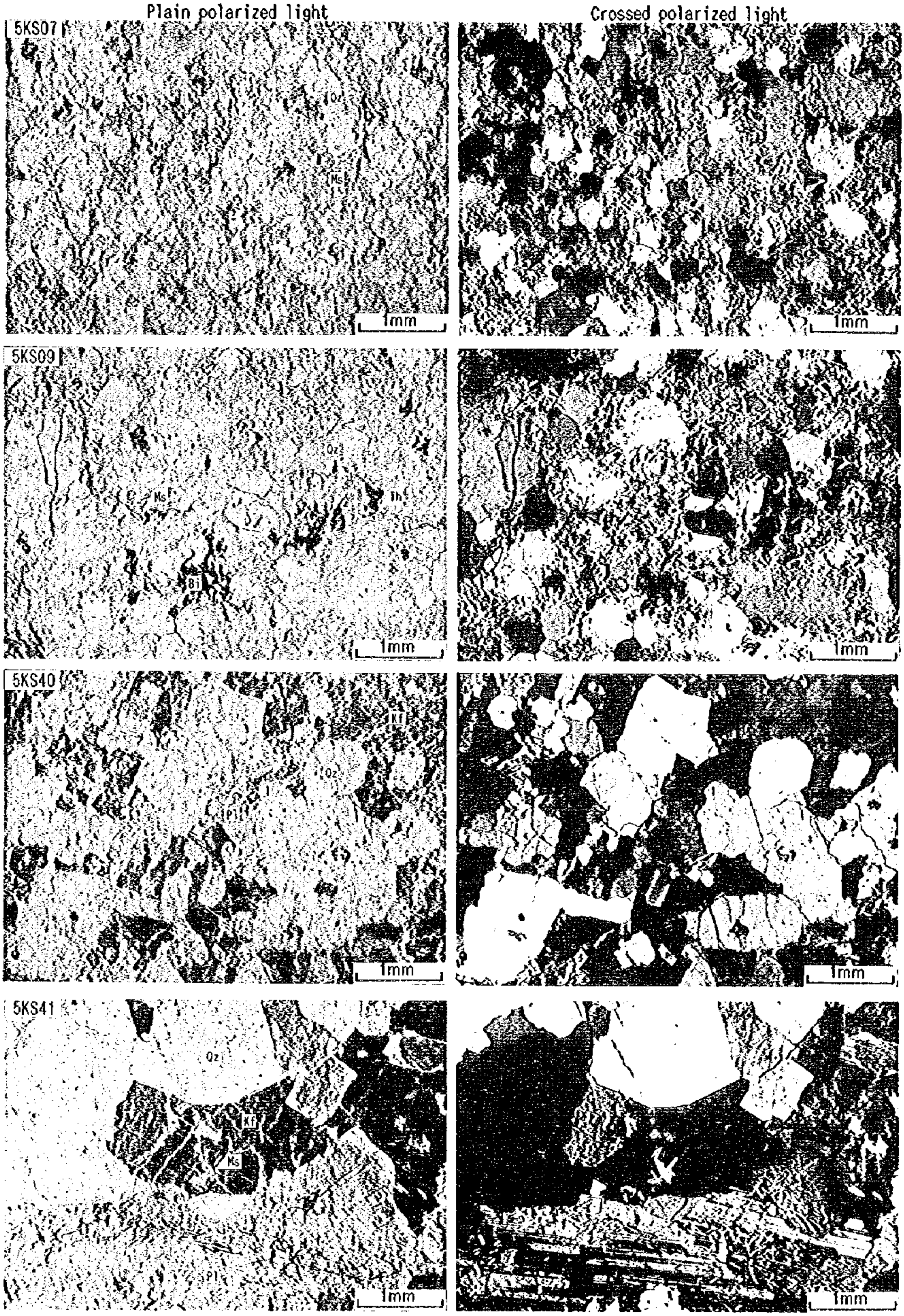
APPENDIX. -3

Microscopic Photographs of Thin Sections

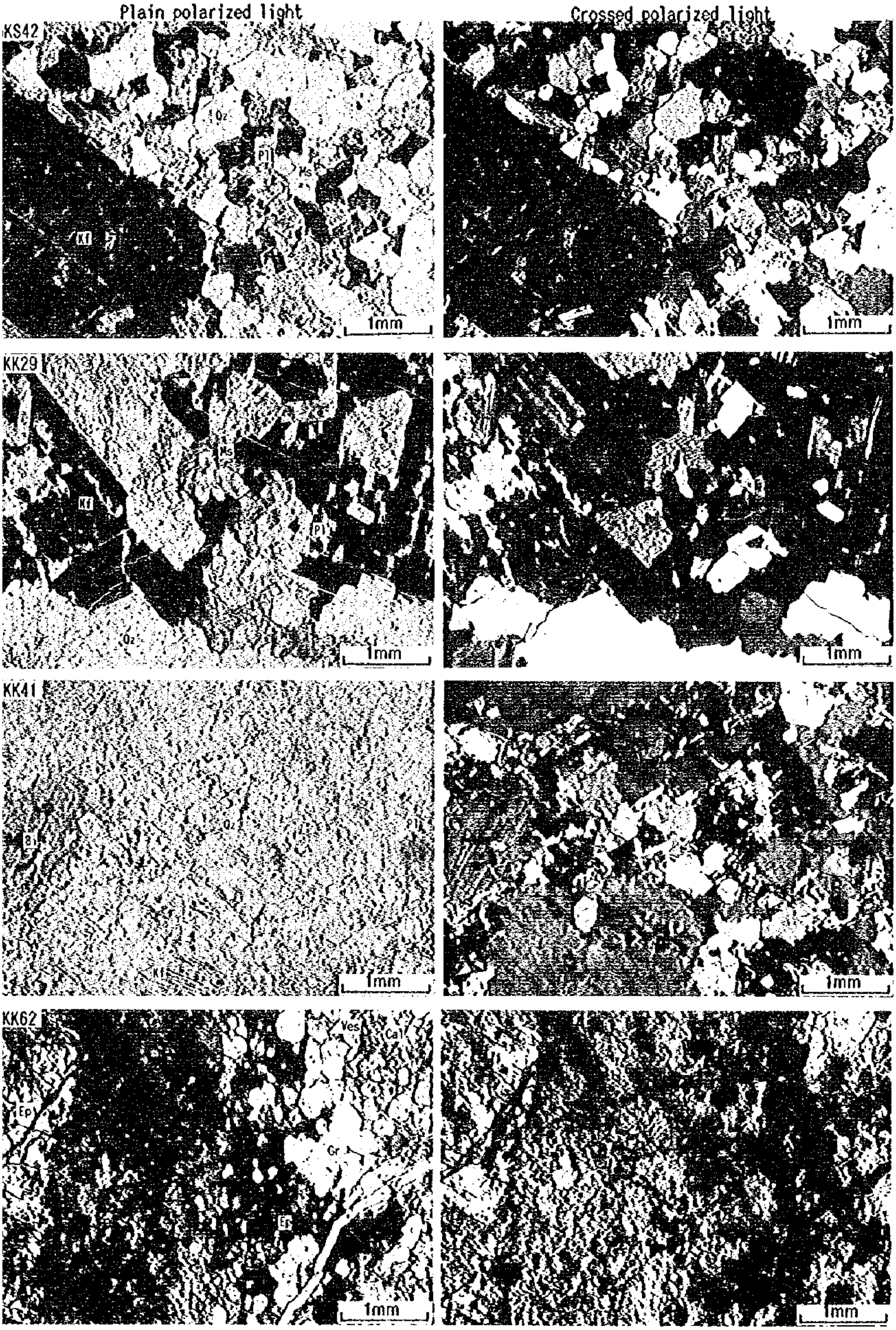
Abbreviations (Thin section)

Bi : Biotite
Cal : Calcite
Ep : Epidote
Gr : Garnet
Kf : K-feldspar
Ms : Muscovite
Pl : Plagioclase
Qz : Quartz
Spn : Sphene
Th : Thorite
Ves : Vesuvianite

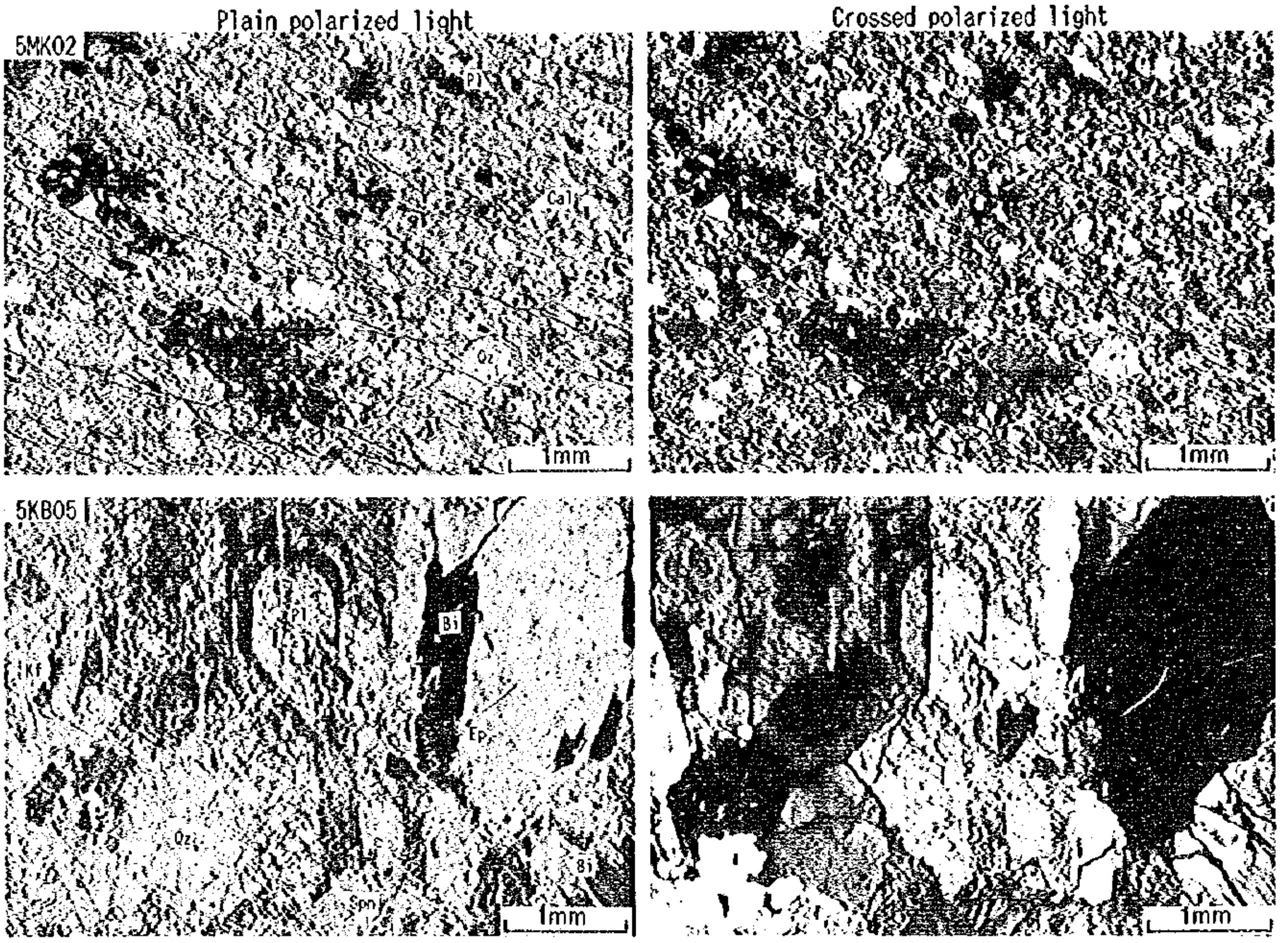
Apx. -3 Microscopic Photographs of Thin Sections (1)



Apx. -3 Microscopic Photographs of Thin Sections (2)



Apx. -3 Microscopic Photographs of Thin Sections (3)



APPENDIX. -4

Result of Microscopic Observations of Polished Sections

Apx.-4 Result of Microscopic Observation of Polished Sections

No.	Sample No.	Locality	Rock name	Pyrite	Pyrrhotite	Arsenopyrite	Melnikovite	Magnetite	Hematite	Goethite	Chalcopyrite	Chalcocite	Bornite	Tetrahedrite	Tennantite	Jamesonite	Bismuthinite	Sphalerite	Galena	Scheelite	Native gold	Native silver	Unknown Ag-mineral	Braunite	Pyrolusite	Psilomelane	Psilomelane-wad	Chalcophanite	Cryptomelane
1	5KS08	Shyraldzhyn deposit	Quartz vein	·						·	·									·	·								
2	5KS11	Shyraldzhyn deposit	Quartz Mn-siderite vein	·						·	·														·				
3	5KS19	Shyraldzhyn deposit	Muscovite-quartz rock	·						·															·				
4	5KS27	Shyraldzhyn deposit	Mn-siderite vein							◎																△		△	
5	5KS36	Shyraldzhyn deposit	Mn-siderite vein							○															○				○
6	5KS39	Shyraldzhyn deposit	Mn-siderite vein	·						◎												·				·		·	
7	5KS45	Shyraldzhyn deposit	Mn-siderite vein							○	·														△				△
8	5KS48	Shyraldzhyn deposit	Mn-siderite vein	·						◎											·				△				
9	5KS53	Shyraldzhyn deposit	Quartz vein	·							·										·								
10	5MS06	Shyraldzhyn deposit	Quartz vein	·						○															△				△
11	5KK14	Kumyshtag	Limestone/hornfels skarn gossan		△						·																		
12	5KK55	Uchimcheck deposit	Arsenopyrite ore	·		◎																·							
13	5KK56	Kumysbtag deposit	Arsenopyrite-pyrite ore	○	·	△					·	·	·	△		·	·						·						
14	5KK57	Kumyshtag deposit	Arsenopyrite ore			◎					·		·		·	·			·										
15	5KK64	Uzuntashty deposit	Magnetite ore	·				○	△	△											·								
16	5YK02	Tuktuarcha deposit	Quartz vein	△			△																						
17	5KB16	Kuru-Bakair deposit	Manganese gossan	·						○	·														△				
18	5KB24	Babahan deposit	Sphalerite ore	·							△			·				◎											
19	5KB25	Dzholsay deposit	Mn-siderite vein							△											·			○	○			○	
20	5KB28	Dzholsay deposit	Mn-siderite ore							○																	○		

◎:Abundant ○:Common △:Poor ·:Rare

Description of Microscopic Observation of Polished Section

1. POLISHED SECTION 5KS08

Composition: Chalcopyrite 3%, hydrous ferric oxides (limonite) 1-2%, pyrite -isolated signs, scheelite - isolated signs, free gold - 2 signs.

Structure: Allotriomorphic granular.

Texture: Impregnated, microstructure: reticulate, rim.

Ore mineralization in the polished section is represented by chalcopyrite, hydrous ferric oxides and isolated grains of pyrite and scheelite.

Chalcopyrite forms allotriomorphic aggregates measuring 0.024 - 0.8 mm in non-metalliferous mass. The color in reflected light is rich-yellow, bright, anisotropic effects are weak, reflection is moderate. Chalcopyrite is fractured and to a considerable extent is substituted by limonite with the formation of reticulate and rim microstructure and, in its turn, replaces pyrite.

Limonite replaces chalcopyrite and pyrite pseudomorphically. It forms variously shaped rims, crusts, reniform and rhythmically zonal aggregates with indented boundaries. The dimensions of grains is from 0.018 to 0.3 mm. The color is gray with the bluish tint, reflection is low, internal reflections are brownish-yellow.

Pyrite is represented in relict configuration, dimensions are from 0.012 to 0.1 mm. The shape is irregular, isometric, sometimes cubic. Pseudomorphically substituted by limonite and chalcopyrite.

Scheelite forms isometric crystals measuring 0.012 - 0.09 mm in non-metalloferous mass.

Free gold is observed in aggregates with quartz and chalcopyrite. Dimensions are 0.006 x 0.006; 0.003 x 0.003 mm. The shape is isometric or near isometric. The color is bright yellow.

2. POLISHED SECTION 5KS11

Composition: Non-metalliferous mass (quartz) 100%, pyrite, chalcopyrite, limonite and pyrolusite - isolated grains.

The polished section is of scanty ore mineralization, represented by separate grains of chalcopyrite, pyrite, limonite and pyrolusite.

Pyrite: Dimensions are 0.008 - 0.03 mm. It is intensively substituted by limonite with the formation of rims. The shape is irregular.

Chalcopyrite : Dimensions are 0.006 - 0.012 mm. Observed in the shape of small isometric impregnation in non-metalloferous mass.

Limonite forms aggregates of irregular shape and veinlets. Pseudomorphically replaces pyrite. Dimensions of the grains are from 0.008 to 0.06 mm. The thickness of the veinlets is from 0.003 to 0.006 mm.

Pyrolusite is observed in the shape of irregular aggregates measuring 0.012 - 0.05 mm and veinlets of 0.006 mm thickness.

3. POLISHED SECTION 5KS19

Composition: Limonite, pyrite, pyrolusite - isolated grains, non-metalliferous matter - 100%.

Ore mineralization is scanty and is represented by isolated grains of pyrite, limonite and pyrolusite.

Limonite is developed in the shape of irregular grains measuring 0.006 - 0.12 mm. It pseudomorphically replaces pyrite, sometimes up to complete pseudomorphes. The thickness of thin veinlets in the non-metalloferous mass is from 0.003 to 0.012 mm.

Pyrite: Dimensions are 0.006 - 0.012 mm. It forms a thin impregnation in non-metalloferous mass. It is also observed in the shape of relics in limonite aggregates.

Pyrolusite is observed in the non-metalloferous mass in the shape of tabular strongly anisotropic crystals measuring 0.03 - 0.6 mm.

4. POLISHED SECTION 5KS27

Composition: Limonite or hydrous ferric oxides 75%, hydrous manganic oxides 15 %, non-metalloferous minerals 10 %.

Texture: U-shaped, vesicular.

Structure: Cryptocrystalline.

The polished section is mainly composed of minerals of group of hydrous ferric and manganic oxides, which are tightly aggregated. The polished section is characterized by hydrous ferric and manganic oxides replacing rhombic crystals of calcite or some other carbonaceous mineral along cleavage cracks and boundaries of grains with partial or complete preservation of crystallographic forms. The direction of the replacement is carbonate - hydrous ferric oxides - hydrous manganic oxides. The minerals of group of hydrous ferric oxides form the main mass of the polished section (75%). The shape of separations is irregular, rhombic, prismatic and has the shape of concentric and festoony formations and veinlets. Dimensions are 0.006 - 0.6 mm. The thickness of the veinlets is from 0.003 to 0.015 mm. The color in the reflected light is gray, reflective power is moderate, weakly anisotropic, internal reflections are brown. The minerals of group of hydrous manganic oxides are represented by psilomelane and chalcophanite.

Psilomelane forms pseudomorph on limonite in the shape of irregular, aggregative and dendrite-shaped separations measuring 0.003 - 0.012 mm. The color in the reflected light is grayish-white, the reflective power is average.

Chalcophanite (variety with low content of zinc) forms tabular crystals, matted-fibrous and radiate-fibrous aggregates measuring 0.003 - 0.3 mm. The color is white, strongly anisotropic with brown internal reflections. Replaces psilomelane pseudomorphically.

5. POLISHED SECTION 5KS36

Composition: Hydrous manganic oxides 50%, hydrous ferric oxides 30%, non-metalliferous minerals 20%.

Structure: Concentric-zonal.

Texture: Vesicular.

In this polished section ore mineralization is represented by minerals of group of hydrous manganic oxides and hydrous ferric oxides which are in a tight intergrowth with each other.

Hydrous manganic oxides are represented by pyrolusite and cryptomelane. They form concentric-zonal, colloform and festoony formations measuring 0.04 - 0.06 mm. The color is gray (various tints), reflection is moderate, anisotropy is distinct, internal reflections are brownish-yellow.

Hydrous ferric oxides (goethite, hydrogoethite) are represented by aggregates of shelly, rhythmically-zonal, net-like shapé, their dimensions vary from 0.03 to 0.06 mm. Pseudomorphically replace manganic minerals. The color in the reflected light is gray, reflection is moderate, anisotropic, internal reflections are brownish-red.

6. POLISHED SECTION 5KS39

Composition: Hydrous ferric oxides (limonite) 55%, hydrous manganic oxides (psilomelane, chalcophanite) 5%, non-metalloferous minerals 40%, pyrite - isolated signs, free silver - 1 sign.

Structure: Cryptocrystalline.

Texture: Subgraphic, vesicular.

In this polished section ore mineralization is represented by limonite with some admixture of psilomelane and chalcophanite.

Limonite forms subgraphic intergrowth with non-metalloferous mineral (quartz and carbonate ?) with the formation of grains of irregular shape measuring 0.012 - 0.1 mm. It contains inclusions of relict grains of pyrite, multiple cavities and emptiness and is replaced by psilomelane and chalcophanite along cracks and in periphery.

Psilomelane in tight intergrowth with chalcophanite pseudomorphically replaces limonite with the formation of matted-fibrous, needle-shaped and prismatic crystals. Dimensions are from 0.006 to 0.05 mm.

Pyrite is observed in relict form and forms in limonite mass small isometric crystals measuring 0.006 - 0.012 mm.

Free silver is observed in limonite aggregate. The shape is isometric, dimensions - 0.009 x 0.009. The color is white with slight cream tint.

7. POLISHED SECTION 5KS45

Composition: Hydrous ferric oxides 45%, hydrous manganic oxides 30%, chalcopyrite 15%, non-metalliferous minerals 10%.

Structure: Cryptocrystalline.

Texture: Vesicular, U-shaped.

Ore mineralization is represented by hydrous ferric and manganic oxides, chalcopyrite, pyrite.

Hydrous manganic oxides are represented by pyrolusite and cryptomelane. They are in tight intergrowth with each other. These minerals form clustered-shelly, rhythmically zonal aggregates measuring 0.04 - 0.8 mm. The microstructure of minerals is concentric-zonal.

Hydrous ferric oxides (goethite, hydrogoethite) form aggregates of lattice-like, rhythmically-zonal shape, and also pseudomorphes on chalcopyrite, pyrite with the formation of lattice-like microstructures and rims. Dimensions are from 0.05 to 1.0 mm.

Chalcopyrite forms grains of irregular shape. Dimensions are from 0.04 to 0.2 mm. It is pseudomorphically replaced by limonite with the formation of relict microstructure. The color is bright-yellow, reflection is moderate, weakly anisotropic.

8. POLISHED SECTION 5KS48

Composition: Hydrous ferric oxides 80%, hydrous manganic oxides 5%, non-metalliferous minerals 13%, pyrite - isolated signs, free gold - 3 signs.

Structure: Cryptocrystalline, in some places - colloform.

Texture: U-shaped, vesicular.

The major mass of the polished section consists of minerals of the group of hydrous ferric oxides (goethite, hydrogoethite) - 80%, some minerals of group of hydrous manganate (pyrolusite) - 5-7% and relic grains of pyrite.

Hydrous ferric oxides form prismatic rhombic-shaped crystals, irregular, festoony, colloform, columnar formations. Very often the form of crystals of hydrous ferric oxides depends on the form of crystals of mineral substituted by them. The color in reflected light is gray, reflective power is moderate, internal reflections are bright- red, weakly anisotropic.

Aggregates of hydrous ferric oxides contain multiple emptiness and cavities of leaching, small relict grains of pyrite and drop-shaped inclusions of free gold. Dimensions of the grains are from 0.018 to 0.3 mm.

The minerals of group of hydrous manganic oxides are observed in the shape of thin veinlets and colloform formations measuring 0,006 - 0.12 mm.

Free gold: The form is elongated, drop-shaped, wire-shaped. The color is bright yellow. Dimensions of separations: 0.015 x 0.006 mm, 0.003 x 0.003 mm, 0.012 x 0.003 mm. The boundaries of intergrowth are regular. Observed in goethite - hydrogoethite mass.

9. POLISHED SECTION 5KS53

Composition: Limonite 1%, non-metalliferous mass 99%, pyrite, chalcopyrite - isolated signs, free gold - 6 signs.

Structure: Hypidiomorphic-granular.

Texture: Impregnated; microstructure: relict.

This ore mineralization is rather scanty and is represented by limonite, isolated grains of pyrite and chalcopyrite.

Limonite forms grains of irregular, isometric, cubic and prismatic shape, dimensions - from 0.006 to 0.7 mm. It pseudomorphically replaces pyrite and chalcopyrite with the preservation of their crystallographic shape. Limonite also forms thin veinlets (of 0.006-0.06 mm thickness) in non-metalloferous mass.

Pyrite is observed in the shape of small crystals of prismatic, cubic and isometric shape. It is also observed in the shape of relics in limonite. Dimensions of grains are from 0.006 to 0.1 mm.

Chalcopyrite forms in non-metalloferous mass small isometric and irregular aggregates measuring 0.01-0.12 mm. It is substituted by limonite up to formation of complete pseudomorph. Sometimes it is observed in limonite aggregates in the shape of non-replaced relics.

Free gold (6 signs). It forms small crystals of isometric, sometimes elongated shape. The color is bright yellow. Dimensions of the crystals are: 0.003 x 0.003, 0.006 x 0.006, 0.006 x 0.012, 0.012 x 0.012, 0.006 x 0.006, 0.015 x 0.015 mm. Observed in intergrowth with non-metalloferous minerals.

10. POLISHED SECTION 5MS06

Composition: Hydrous ferric oxides (goethite, hydrogoethite) 35%, hydrous manganic oxides (pyrolusite, cryptomelane ?) 25%, pyrite - isolated signs, non-metalloferous mass 40%.

Structure: Cryptocrystalline.

Texture: Vesicular, U-shaped.

Hydrous manganic oxides are represented by oolitic-shaped, concentric-zonal, reniform and cluster-shaped aggregates with the formation of colloform microstructure of manganic separations. Their composition is non-uniform and two phases can be pointed out here. Phase I is represented by pyrolusite. It is gray with some cream tint in reflected light, its reflective power is high, double reflection is distinct, anisotropic. It forms aggregates measuring 0.06-0.5 mm. Phase II is represented by cryptomelane. It is observed in a tight intergrowth with pyrolusite and replaces it. Pyrolusite forms irregular, ameba-shaped and bay-shaped aggregates measuring 0.03-1,0 mm. Reflection is moderate, color is grayish-white, anisotropic.

Hydrous ferric oxides form aggregates of irregular and fibrous shape, dimensions from 0.03 to 0.6 mm. It replaces non-metalloferous mineral (presumably carbonaceous) along the cleavage zones and inter-granular seams with the formation of lattice-like microstructure. It forms reniform aggregates and aggregates of concentric-zonal shape in a tight intergrowth with the minerals of group of hydrous manganic oxides. The color in reflected light is grayish-blue, reflection is low, anisotropy is weak, internal reflections are reddish-brown.

Pyrite is observed in the shape of small relict grains in goethite-hydrogoethite mass and also small isometric separations in quartz. Dimensions are from 0.012 to 0.04 mm.

11. POLISHED SECTION 5KK14

Composition: Pyrrhotite 15%, chalcopyrite 1%, non-metalliferous minerals 84%.

Structure: Hypidiomorphic.

Texture: Impregnated.

The ore mineralization is represented by pyrrhotite and small quantities of chalcopyrite.

Pyrrhotite forms impregnation of irregular, isometric, tabular and prismatic shape in non-metalliferous mass. Dimensions of grains are from 0.018 to 0.06 mm. Along the cracks the grains of pyrrhotite are replaced by marcasite. It contains multiple inclusions of non-metalliferous minerals and forms aggregates with chalcopyrite. The color in reflected light is light-yellow with cream tint, reflective power is high, anisotropy is strong.

Chalcopyrite forms small isometric and irregular aggregates in non-metalliferous mass measuring 0.006 -0.12 mm. It forms aggregates with pyrrhotite with the formation of indented boundaries. The color in reflected light is bright--yellow, the effects of anisotropy are weak, reflection is moderate.

12. POLISHED SECTION 5KK55

Composition: Arsenopyrite 70%, pyrite - isolated signs, non-metalliferous minerals, silver - 1 sign.

Structure: Hypidiomorphic-granular.

Texture: Massive.

The ore mineralization is represented by arsenopyrite.

Arsenopyrite forms hypidiomorphic grains with negligible crenulation. Dimensions of grains is from 0.06 to 5.0 mm. The shape is tabular, prismatic with typical rhombic cross-section.

The crystals of arsenopyrite are strongly fractured and contain multiple inclusions of non-metalliferous minerals.

The color in reflected light is white, the effects of anisotropy are strong with considerable color effects, reflection is high.

Pyrite is observed in the shape of small impregnation in non-metalliferous mass. Dimensions of grains are from 0.006 to 0.03 mm.

Free silver (1 sign), dimensions are 0.03 x 0.012 mm. The shape is slightly elongated. The color is white with cream tint. It is observed in intergrowth with non-metalliferous minerals (in a crack).

13. POLISHED SECTION 5KK56

Composition: Pyrite 20%, arsenopyrite 5%, gray ore 5%, jamesonite 1-2%, chalcopyrite, bornite 1%, chalcocite, pyrrhotite, minerals of silver.

Texture: Veinlet-impregnated.

Ore mineralization is widely developed and makes up 30-35% of the area of the section.

Pyrite composes 1.0 cm thick veinlets and grains measuring 01 - 0.5 mm. The boundaries of the intergrowth of grains have polygonal profile. Some small quantities of pyrite are observed in non-metalliferous mass in the form of isolated metacrystals. The surface of pyrite grains is irregular and of cribrate form because of large quantity of inclusions of non-metalliferous minerals.

Microstructures for pyrite: allotriomorphic-granular, metablastic.

Arsenopyrite is represented by separate columnar-radial grains, aggregates of grains having isometric, irregular shape. Dimensions of the grains is from 0.01 to 0.2

mm. It is observed in the form of inclusions in non-metalliferous minerals (quartz, carbonate) and also in all the ore minerals with the exception of pyrite.

Microstructure: metablastic, poikiloblastic, interstitial.

Gray ore is represented by copper-antimony variety - tetrahedrite. It is observed in the form of aggregate of isometric slightly indented grains, composing separations measuring 1.0 - 1.5 mm and also in the form of thin rims surrounding the grains of quartz. Gray ore contains multiple inclusions of needles of arsenopyrite, separations of chalcopyrite having irregular form, bornite, chalcocite, silver minerals, bismuthite. Some separations of gray ore have tabular separations of bournonite (?).

Microstructures: interstitial, limbate, poikiloblastic, structure of disintegration (bismuthite, bournonite in gray ore).

Jamesonite is observed in the shape of isolated needle-shaped crystals with the typical rhombic cross-sections, dimensions from 0.01 to 0.3 mm, and also forms continued palmate-indented intergrowth the dimensions of which vary from 0.2 to 1.5 mm. Needle-shaped jamesonite forms intergrowth with non-metalliferous mineral. Other jamesonite separations form intergrowth both with non-metalliferous and ore minerals - arsenopyrite, gray ore, chalcopyrite.

The boundaries of intergrowth: straight, sinuous.

Microstructures: interstitial, metablastic.

Chalcopyrite is spread uniformly both in non-metalliferous and ore areas. It does not form large separations. The shape of separations is irregular, palmate with sinuous boundaries. Dimensions of separations are from 0.02 to 0.3 mm. In the form of inclusions it is observed in gray ore, arsenopyrite, pyrite, jamesonite and also fills interstice between non-metalliferous minerals.

Microstructures: poikilitic, interstitial.

Bornite is observed mainly in gray ore together with chalcocite in the form of transformation twins having the shape of "oleander leaves" as a result of disintegration of solid solution with the separation of chalcocite and bornite in the shape of peculiar net-like formations having convex bornite part and concave chalcocite part.

Pyrrhotite is observed in subordinate quantity in gray ore in the intergrowth with quartz in the shape of small elongated grains measuring 0.07 mm.

Bismuthite is observed in gray ore in the shape of isolated needle-like separations measuring 0.05 - 0.1 mm.

Minerals of silver are observed in gray ore in the form of products of disintegration of solid solutions. These are multiple separations of oval, isometric and drop-like shape, measuring 0.001 - 0.02 mm.

14. POLISHED SECTION 5KK57

Composition: Arsenopyrite 55%, non-metalliferous mass 45%, tennantite, jamesonite, galena, bornite, chalcopyrite - isolated grains.

Structure: Hypidiomorphic-granular.

Texture: Impregnated.

The ore mineralization is mainly represented by arsenopyrite, which forms irregular impregnation in non-metalliferous mass. Jamesonite, chalcopyrite, galena, bornite are observed in small quantities. They are mainly observed in non-metalliferous mass, but sometimes they form aggregates with each other or with arsenopyrite.

Arsenopyrite forms prismatic crystals, aggregates of crystals, including stellate, columnar, radial ones. Their dimensions are from 0.018 to 1.5 mm. The color is white in reflected light with slight color tint, reflection is high, double reflection is not strong. It is distinctly anisotropic with color effect in crossed nicols.

Tennantite forms grains of irregular, isometric form, measuring from 0.006 to 0.028 mm. Aggregates with arsenopyrite, jamesonite, chalcopyrite have dented boundaries. Sometimes on periphery chalcopyrite replaces arsenopyrite.

Chalcopyrite forms small crystals of irregular and sometimes of tabular form measuring 0.003 - 0.08 mm. It contains inclusions of arsenopyrite and is replaced by tennantite, bornite.

Bornite is observed in the shape of irregular grains measuring 0.03 - 0.1 mm. It pseudomorphically replaces chalcopyrite and contains inclusions of arsenopyrite.

Galena forms irregular isometric grains measuring 0.01 - 0.3 mm. It contains inclusions of jamesonite.

Jamesonite forms isometric, irregular and drop-like aggregates measuring 0.026 - 0.12 mm. It also forms aggregates with tennantite, galena, arsenopyrite.

15. POLISHED SECTION 5KK64

Composition: Magnetite 30%, hydrous ferric oxides (limonite) 10%, pyrite - isolated signs, non-metalliferous mass 45%, free gold - 2 signs.

Structure: Hypidiomorphic-granular, fibrous in places.

Texture: Impregnated.

Magnetite forms needle-like, matted-fibrous, radial, irregular and isometric aggregates. Hematite is developed along magnetite with the formation of relict microstructure. Hematite replaces magnetite up to formation of complete pseudomorph. Dimensions of grains are from 0.008 to 1.0 mm. The color in reflected light is gray with brown tint, reflection is moderately low, isotropic.

Hematite is represented by thin-needle-like aggregates measuring 0.004 - 0.06 mm. It replaces magnetite pseudomorphically and, in its turn, is replaced by limonite. The color is gray with blue tint, anisotropy is distinct, internal reflections are ruby-red, reflection is moderately low. It is much lighter in color than magnetite. Microstructure of corrosion.

Limonite is observed in the form of irregular shelly and concentrated-zonal masses measuring 0.02 - 1.0 mm. It pseudomorphically replaces pyrite and hematite with the formation of relict microstructure. It contains multiple relics of hematite, magnetite, pyrite.

Free gold (2 signs). The color is bright yellow. The dimensions are 0.004 x 0.004, 0.08 x 0.004 mm. The shape is isometric and is observed in intergrowth with non-metalliferous mineral, presumably mica. The boundaries of intergrowth are regular.

Pyrite is observed in the shape of small relict grains in limonite mass, dimensions are from 0.004 to 0.06 mm.

16. POLISHED SECTION 5YK02

Composition: Pyrite 5%, melnikovite 10%, non-metalliferous mineral 85%,
magnetite - isolated signs.

Structure: Allotriomorphic-metagranular.

Texture: Impregnated.

The ore mineralization is represented by pyrite and melnikovite (Fe_3S_4). These minerals form tight intergrowth with each other with the formation of indented boundaries.

Melnikovite is represented by fine-granular aggregates of concentric-zonal, calcium-like banded, irregular and more seldom isometric shape. Dimensions are from 0.006 to 1.0 mm. The aggregates of melnikovite are strongly fractured and contain multiple cavities of leaching. In some places melnikovite forms subgraphic intergrowth with non-metalliferous mineral. The microstructure of the mineral is concentric-zonal, sometimes powdery. The reflective power is somewhat lower than that of pyrite, the color is light-yellow, the effects of anisotropy are not present.

Pyrite forms crystals of isometric, cubic and irregular shape, dimensions from 0.04 to 0.8 mm. The crystals of pyrite are fractured and contain multiple inclusions of non-metalliferous minerals. The color in reflected light is straw-yellow, reflective power is moderately high, isotropic.

17. POLISHED SECTION 5KB16

Composition: Hydrous ferric oxides 40%, pyrolusite 15%, non-metalliferous minerals 45%, pyrite - isolated signs, chalcopyrite - isolated signs.

Structure: Allotriomorphic-granular.

Texture: Banded, microstructure of border rims, relic.

The major area of the polished section is occupied by minerals of group of hydrous ferric oxides (limonite) - 40% with some admixture of manganic minerals (pyrolusite ?) - 15%. Hydrous ferric oxides form aggregates of irregular form measuring 0.006 - 0.12 mm. It also forms veinlets 0.001 - 0.006 mm thick in non-metalliferous mass.

It replaces pyrite in the shape of concentric-zonal formations and periphery margins with the formation of microstructure of border rims. The color in reflected light is gray of various tints, weakly anisotropic with multiple reddish-brown internal reflections.

In tight intergrowth with limonite are minerals of group of hydrous manganic oxides (here, pyrolusite). Pyrolusite makes cryptocrystalline formations measuring 0.006 -0.36 mm. The color is bluish-gray in reflected light, anisotropic.

The aggregates of pyrolusite contain multiple cavities and also inclusions of thin-needled minerals (presumably rutile or amphibole).

In non-metalliferous mass and in limonite along cracks pyrolusite forms 0.003 - 0.03 mm thick veinlets.

Pyrite forms dimensions from 0.003 to 0.012 mm, observed in relict shape in the mass of concentric-zonal and festoony formations of limonite. The color in reflected light is light-yellow, isotropic.

18. POLISHED SECTION 5KB24

Composition: Sphalerite 84%, chalcopyrite 5%, pyrite 1%, non-metalliferous minerals 5-10%, tetrahedrite - isolated signs.

Structure: Allotriomorphic-metagranular.

Texture: Massive.

The ore mineralization is mainly represented by sphalerite and some small quantity of chalcopyrite and pyrite.

Sphalerite forms granular aggregates, dimensions of the grains making up 0.06 - 1.5 mm. Its grains are strongly fractured, cracks are filled with non-metalliferous mineral (quartz). It contains emulsionous impregnation of chalcopyrite and inclusions of small idiomorphic grains of pyrite. The color in reflected light is light-gray, reflective power is low, isotropic, internal reflections are light-brown.

Chalcopyrite is observed exclusively in sphalerite in the form of emulsion impregnation. The shape of grains is isometric, sometimes elongated, dimensions are from 0.006 to 0.03 mm. Microstructure of the mineral is emulsionous. Pyrite is also observed in the form of impregnation in sphalerite, dimensions are from 0.006 to 0.18 mm. The shape of separations is cubic, octahedral and in the form of veinlets, composed of crystals of pyrite tightly joining each other, thickness is from 0.006 to 0.06 mm.

Tetrahedrite forms crystals in sphalerite irregularly. The color is grayish-green with bluish tint, dimensions from 0.012 to 0.15 mm. The thickness of the veinlets is from 0.006 to 0.06 mm.

19. POLISHED SECTION 5KB25

Composition: Psilomelane-wad 80%, hydrous ferric oxides (limonite) 5 %, non-metalliferous minerals 15%, free gold - 1 sign.

Structure: Cryptocrystalline.

Texture: Vesicular.

Almost all the area of the polished section is occupied by minerals of group of psilomelane-wad, which are of different composition. Pyrolusite, braunite, chalcophanite and limonite are observed here. The description of these minerals is as follows.

Braunite forms rather large crystals measuring 0.03 - 0.06 mm. The color in reflected light is grayish-white with cream tint, weakly anisotropic, reflective power is average, internal reflections are not observed. Braunite is strongly replaced by pyrolusite, beginning from internal parts, with the formation of various margins, bays, veinlets. The color of pyrolusite in reflected light is bluish-gray, distinctly anisotropic, reflective power is the same as that of braunite. The average dimensions of grains are from 0.006 to 0.06 mm.

Chalcophanite is observed in this braunite-pyrolusite mass in the shape of islands, veinlets and small often bent tablets. Its color is white, reflective power is high; effects of anisotropy are strong. It is obvious that it is developed both on braunite and pyrolusite, sometimes it forms emulsionous impregnation in these minerals. The dimensions of aggregates are from 0.003 to 0.06 mm, the thickness of the veinlets is from 0.015 to 0.06 mm.

Limonite is observed in the shape of irregular aggregative accumulations, veinlets and separate isometric separations, dimensions are from 0.006 to 0.03 mm. The thickness of veinlets is from 0.03 to 0.06 mm. The color is gray, reflective power is low, internal reflections are brown.

Free gold (1 sign). The color is light-yellow, the shape is isometric, dimensions are 0.003 x 0.003 mm. In association with manganic minerals.

20. POLISHED SECTION 5KB28

Composition: Psilomelane-wad 55%, hydrous ferric oxides (limonite) 10%, non-metalliferous mass 35%.

Texture: Banded, microstructure subgraphic.

Structure: Cryptocrystalline.

The major area of the polished section is composed of minerals of group of psilomelane-wad, which may be divided into three components. The first two components are manganic minerals which differ from each other in color (in reflected light), reflective power and type of separations. The third component are the minerals of group of hydrous ferric oxides or limonite. The description of the above mentioned minerals is as follows.

Component No 1. : This is an anisotropic mineral of gray color with slight greenish tint and of moderate reflective power. It forms small cryptocrystalline masses of irregular form (dimensions are from 0.006 to 0.018 mm).

Component No 2. : This mineral is of higher reflective power than mineral No 1. Its color in reflected light is bluish-gray, distinctly anisotropic. It forms pseudomorph on mineral No 1 with the formation of margins on periphery, rhythmic and thread-like veinlets, bay-shaped and ameba shaped aggregates. It corrodes mineral No 1 from inside, along cracks and boundaries of grains. The dimensions of separations are from 0.006 to 0.03 mm.

Component No 3. Hydrous ferric oxides (limonite). Here all the transitions of intergrowth of manganic minerals with limonite through thin branching of cracks are observed with further separate granular, but rather thin-granular masses measuring 0.003 - 0.006 mm.

Limonite also forms very thin (0.006 - 0.012 mm) veinlets in non-metalliferous mass.

All these minerals intergrow in each other and form variously shaped aggregates and isolations, which, in their turn may be divided into three groups:

1. Thin intergrowth of manganic minerals into non-metalliferous minerals or so called subgraphic replacement of non-metalliferous minerals (of carbonaceous-quartz composition) by manganic minerals.

2. "Vast" psilomelane areas (dimensions from 0.2 to 1.5 mm) containing multiple inclusions of non-metalloferous minerals.

3. Oolite-like formations, composed of thin granular psilomelane masses, located in the form of concentric zonal bands around the central part, which is composed of the same material.

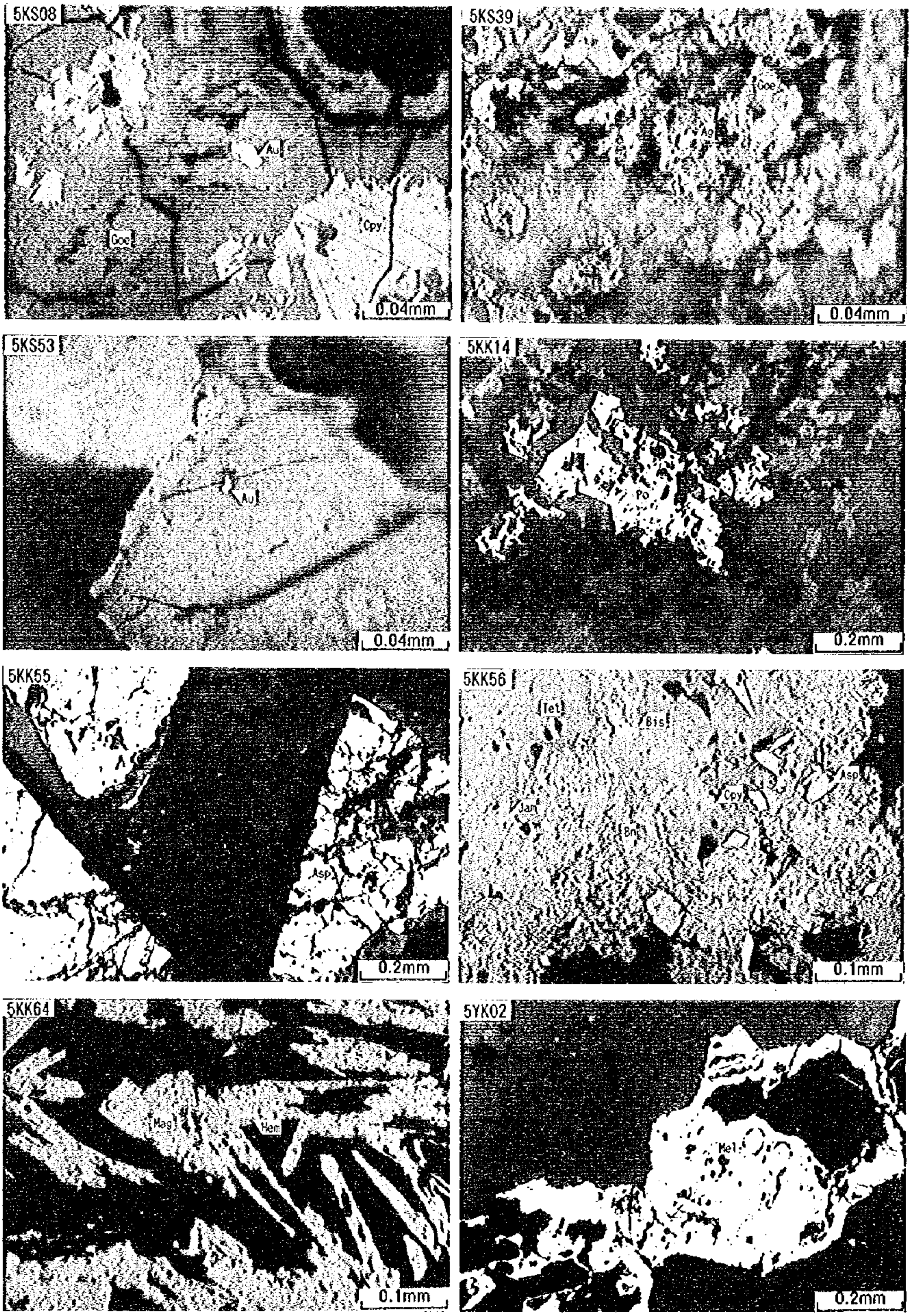
APPENDIX. -5

Microscopic Photographs of Polished Sections

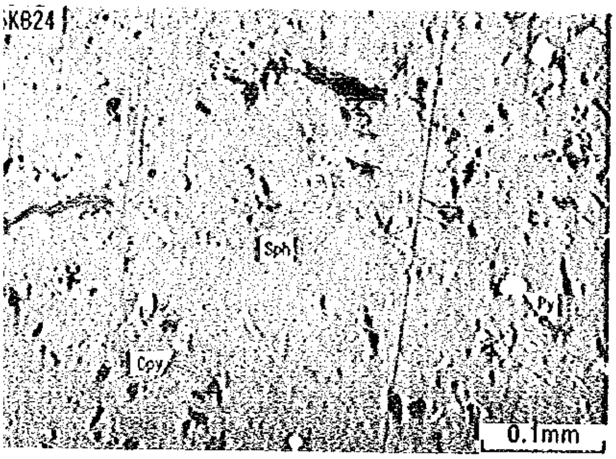
Abbreviations (Polished section)

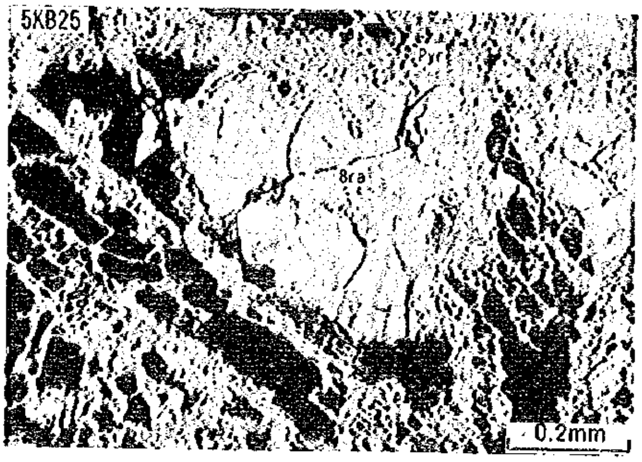
Ag	: Native silver
Asp	: Arsenopyrite
Au	: Native gold
Bis	: Bismuthinite
Bn	: Bornite
Bra	: Braunite
Cpy	: Chalcopyrite
Goe	: Goethite
Hem	: Hematite
Jam	: Jamesonite
Mag	: Magnetite
Mel	: Melnikovite
Po	: Pyrrhotite
Py	: Pyrite
Pyr	: Pyrolusite
Sph	: Sphalerite
Tet	: Tetrahedrite

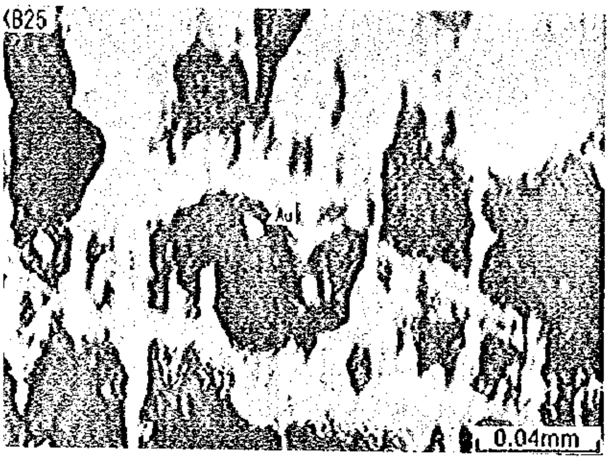
Apx. -5 Microscopic Photographs of Polished Sections (1)



Apx. -5 Microscopic Photographs of Polished Sections (2)







APPENDIX. -6

Assay Results of Ore Samples

Apx.-6 Assay Results of Ore Samples (1)

No.	Sample No.	Location	Ore name	Width (m)	Au (g/t)	Ag (g/t)	Cu (%)	As (%)
1	5KS01	Shyraldzhyn main orebody, K175	Mn-siderite vein	3.2	19.6	3.5	3.40	<0.05
2	5KS02	Shyraldzhyn main orebody, K175	Altered granite	0.5	<0.1	3.6	<0.05	<0.05
3	5KS04	Shyraldzhyn main orebody, K174	Mn-siderite vein	3.0	12.8	0.94	3.00	<0.05
4	5KS05	Shyraldzhyn main orebody, K174	Quartz vein	1.3	4.5	1.0	0.43	<0.05
5	5KS06	Shyraldzhyn main orebody, K174	Muscovite-quartz rock	0.6	0.3	1.2	0.08	0.05
6	5KS07	Shyraldzhyn main orebody, K174	Muscovite-quartz rock	0.5	<0.1	<0.3	<0.05	0.05
7	5KS08	Shyraldzhyn main orebody, K172	Quartz vein	0.6	3.9	49.9	0.81	0.06
8	5KS11	Shyraldzhyn main orebody, K170	Quartz Mn-siderite vein	1.3	9.3	1.7	0.78	0.06
9	5KS13	Shyraldzhyn main orebody, K169	Mn-siderite vein	0.2	15.5	6.6	0.55	0.05
10	5KS18	Shyraldzhyn main orebody,K101SE	Sheared altered granite	0.6	<0.1	0.34	0.07	0.23
11	5KS19	Shyraldzhyn main orebody,K101SE	Muscovite-quartz rock	6.4	<0.1	1.6	0.05	0.06
12	5KS22	Shyraldzhyn main orebody, K106	Quartz vein with Mn-siderite	1.5	0.6	<0.3	0.28	0.05
13	5KS23	Shyraldzhyn main orebody, K106	Mn-siderite vein	2.0	1.1	0.65	0.47	0.08
14	5KS24	Shyraldzhyn main orebody, K107	Mn-siderite vein	3.7	2.9	1.0	0.92	<0.05
15	5KS25	Shyraldzhyn main orebody, K102	Mn-siderite vein	1.2	7.7	6.4	0.73	<0.05
16	5KS27	Shyraldzhyn main orebody, K102	Mn-siderite vein	2.5	0.2	1.0	0.50	<0.05
17	5KS28	Shyraldzhyn main orebody, K102	Sheared Mn-siderite ore	1.1	1.0	3.4	0.39	0.07
18	5KS29	Shyraldzhyn main orebody, K120	Sheared granite with muscovite	1.0	<0.1	<0.3	<0.05	0.05
19	5KS30	Shyraldzhyn main orebody, K120	Sheared quartz vein	1.0	<0.1	<0.3	<0.05	<0.05
20	5KS31	Shyraldzhyn main orebody, K120	Sheared granite	1.0	<0.1	1.6	<0.05	0.05
21	5KS34	Shyraldzhyn near contact north	Mn-siderite vein (from adit)	0.7	3.9	1.8	1.20	0.05
22	5KS36	Shyraldzhyn near contact north	Mn-siderite vein (from adit)	0.5	4.9	1.3	0.62	0.19
23	5KS38	Shyraldzhyn near contact north	Mn-siderite vein (from adit)	0.8	9.7	3.2	2.60	0.06
24	5KS39	Shyraldzhyn near contact north	Mn-siderite vein	0.4	1.4	0.7	0.99	0.05
25	5KS44	Shyraldzhyn near contact, B-5	Mn-siderite vein	1.2	0.4	0.32	0.64	0.06
26	5KS45	Shyraldzhyn near contact, B-4	Mn-siderite vein	1.0	5.8	2.6	2.60	0.05
27	5KS46	Shyraldzhyn near contact, B-3	Mn-siderite vein	0.3	0.6	0.3	0.06	0.05
28	5KS48	Shyraldzhyn near contact, B-1	Mn-siderite vein	2.0	1.4	0.32	0.88	0.05
29	5KS52	Shyraldzhyn main orebody, K101	Quartz vein	0.2	<0.1	<0.3	<0.05	<0.05
30	5KS53	Shyraldzhyn main orebody, K101	Quartz vein	0.3	0.95	<0.3	2.60	<0.05

Apx.-6 Assay Results of Ore Samples (2)

No.	Sample No.	Location	Ore name	Width (m)	Au (g/t)	Ag (g/t)	Cu (%)	As (%)
31	5KS54	Shyraldzhyn main orebody, K101	Muscovite-quartz rock	0.8	<0.1	<0.3	<0.05	0.09
32	5MS01	Shyraldzhyn contact south K188	Mn-siderite vein with green copper	0.7	28.4	3.6	1.40	0.10
33	5MS05	Shyraldzhyn contact south K190	Quartz Mn-siderite vein	0.3	19.4	1.2	0.18	0.24
34	5MS06	Shyraldzhyn contact south K191	Quartz vein	0.4	9.8	2.2	0.22	0.42
35	5MS09	Shyraldzhyn contact south	Mn-siderite vein	0.3	2.0	1.2	0.40	0.14
36	5MS10	Shyraldzhyn contact south K194	Quartz vein with Mn-siderite	0.3	1.35	<0.3	0.50	<0.05
37	5MS11	Shyraldzhyn contact,K530 south	Clay vein with green copper	0.3	0.2	187.0	0.13	0.24
38	5MS12	Shyraldzhyn contact,K530 south	Mn-siderite vein	0.3	1.8	0.82	3.40	<0.05
39	5MS13	Shyraldzhyn main orebody, K101	Limonitizated granite	4.0	0.6	<0.3	<0.05	0.05
40	5MS14	Shyraldzhyn main orebody, K102	Mn-siderite vein	0.7	4.2	1.8	0.65	0.05
41	5MS17	Shyraldzhyn main orebody, K101	Limonitizated granite	1.4	0.1	1.2	<0.05	<0.05
42	5KK14	Kumyshtag river middle reaches	Limestone/hornfels skarn gossan	2.0	0.55	1.0	0.06	<0.05
43	5KK18	Kumyshtag river middle reaches	Hornfels gossan	6.0	0.1	<0.3	<0.05	<0.05
44	5KK21	Kumyshtag river middle reaches	Quartz vein	0.1	0.35	<0.3	<0.05	<0.05
45	5KK23	Manka Bulak upper reaches	Quartz vein	0.1	0.1	<0.3	<0.05	<0.05
46	5KK41	Cheten deposit	Granite porphyry	1.0	<0.1	<0.3	<0.05	<0.05
47	5KK54	Uchimcheck mine site	Altered limestone/shale	1.0	0.2	16.2	<0.05	16.50
48	5KK55	Uchimcheck mine site,waste	Arsenopyrite ore		0.8	1.2	0.08	10.47
49	5KK56	Kumyshtag mine site,waste	Arsenopyrite-pyrite ore		0.3	1,927.8	<0.05	1.85
50	5KK60	Uzuntashty deposit	Quartz vein	0.8	0.1	<0.3	0.47	<0.05
51	5KK65	Uzuntashty deposit	Fluorite vein	0.8	<0.1	<0.3	<0.05	<0.05
52	5KK66	Uzuntashty deposit	Quartz vein	0.8	0.15	<0.3	<0.05	<0.05
53	5YK02	Kumyshtag river	Quartz vein	0.3	0.5	3.4	<0.05	0.14
54	5YK03	Kumyshtag river	Quartz vein	0.2	<0.1	<0.3	<0.05	<0.05
55	5KB16	Kuru Bakair	Manganese gossan	2.0	0.1	14.6	<0.05	<0.05
56	5KB19	Kuru Bakair	Quartz vein	0.3	<0.1	3.0	<0.05	<0.05
57	5KB20	Babahan deposit	Quartz vein	0.1	<0.1	<0.3	<0.05	<0.05
58	5KB25	Dzholsay deposit	Mn-siderite vein	0.7	<0.1	15.9	<0.05	<0.05
59	5KB26	Dzholsay deposit	Mn-siderite vein	1.5	0.1	16.5	<0.05	0.11
60	5KB28	Dzholsay deposit,waste	Mn-siderite ore		0.1	14.5	<0.05	<0.05