

第V部 総合解析

以上各部で述べたように、本年度に実施した各調査においてそれぞれ下記の結果を得た。

(1) 地質調査

本地域の地質は複合基盤岩類のMosetse river Gneiss層群とMatsitama Schist and metasedimentary層群、これに貫入する火成岩類および表層堆積物よりなる。

物理探査で異常の原因の1つとされた石ぼくの存在は確認できなかった。

(2) 地化学探査

土壌地化学探査では銅、鉛、亜鉛の3元素につき単一変量による解析と主成分分析法による多変量解析を行った。その結果数多くの地化学異常域が得られた。異常域は4区域に大別されるが、それらは北部のものを除きいずれも地層の分布とほぼ調和的な分布を示しており、前述の物理探査による異常域もほぼこの各区域中に集中した。

(3) 空中物理探査

INPUT電磁法により調査地域内において47の異常域を認めた。そのうちBedrockに基因すると考えられる異常域(コンダクターは塊状硫化物か石ぼく)は地層の配列方向と調和的に配列しており、それらを次のように南から北へ7つの帯に分けた。

A M-1' (Matsitama 鉛床群胚胎層準の直上でのチェック)

B M-2, M-3, M-4

C M-9, M-8, M-7D, M-7C, M-7B, M-10, M-11, M-7A,
M-6

D M-32, M-31, M-33, M-26, M-30, M-29, M-27,
M-28

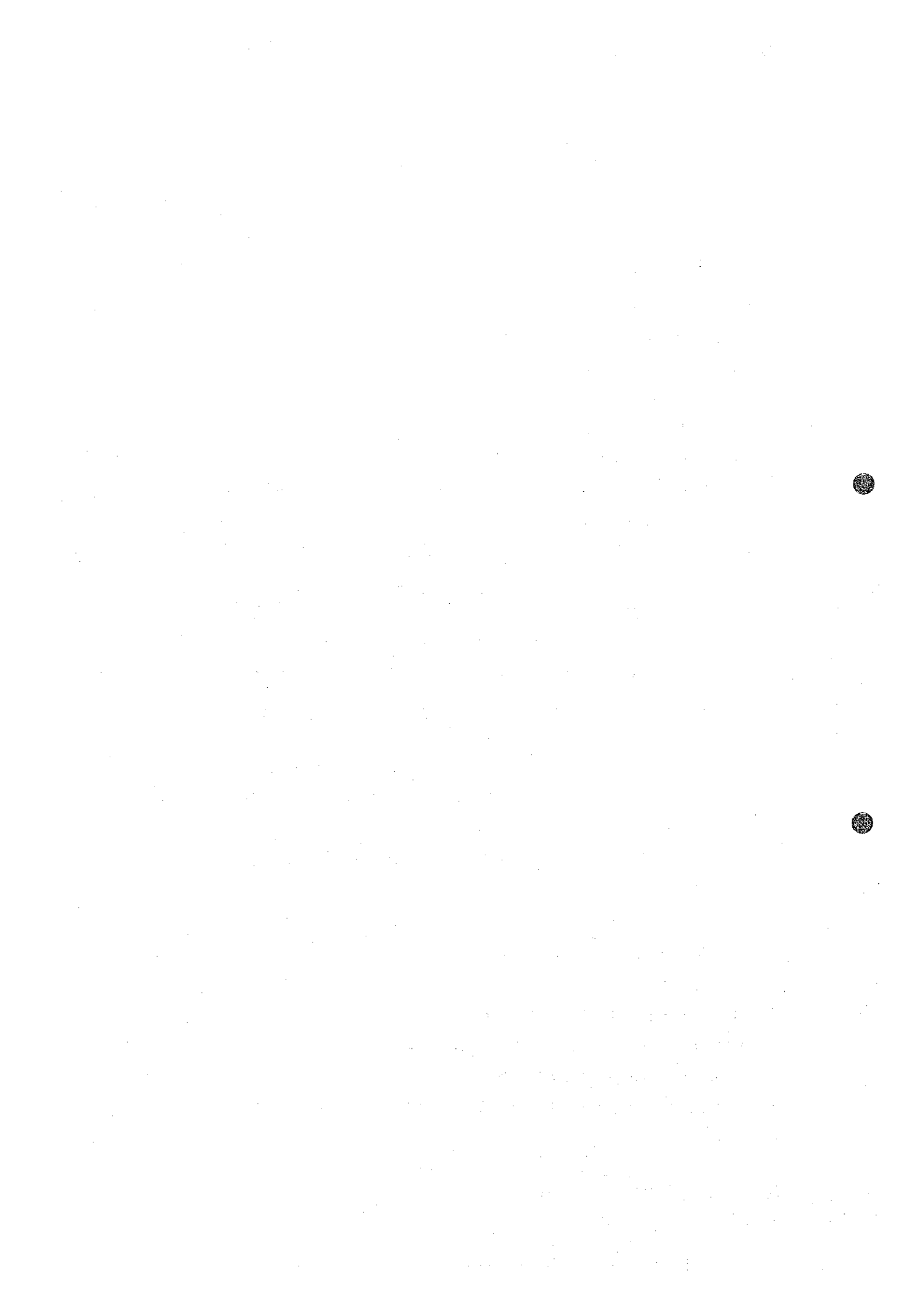
E M-17, M-16, M-15, M-14, M-18, M-19, M-20,
M-21, M-22, M-23, M-23A, M-24A, M-24, M-25

F M-35

G M-36, M-37, M-38

磁気探査の結果によると、上記のBedrock異常域のD, F, Gが比較的磁気異常軸と整合しており、磁性体との関係が推定される。

しかし、全般的には両者の関係は見られず、磁気異常は塩基性岩脈により生じていることが



推測される。

放射能異常はU(ウラン)についてコンター図化した。異常の分布は本地域の西部に集中しているようであるが、明瞭な集中や配列は認められない。放射能異常とINPUT EMの異常配列や空中磁気異常との相関関係あるいは地質構造との関係も明瞭でない。

(4) 地上物理探査

空中物理探査の結果得られた47の異常域から地質状況や異常の配列分布に留意して26の異常域を抽出し、それらについてPulse EM, IP, 磁気探査を実施した。その結果、石ぼくあるいは硫化物に基因すると考えられる下記の異常域が確認された(M-1はMatsitama, Takadu 鉱床上のチェックにつき除外)。

M-2, M-3, M-4, M-7A, M-7B, M-7C, M-7D, M-9, M-10

M-14, M-16, M-18, M-19/20, M-21, M-23, M-23A,

M-24, M-25, M-28/29, M-35, M-36 (Section V-5-3)

以上のうち若干でも硫化鉱物に関連したと思われる異常域は、M-3, M-4, M-7B, M-7C, M-10, M-35で、他は石ぼくによる異常域と判定された。

(5) 総合解析

各調査法による異常域は帯状分布を示し、calcrete—角閃片岩—石灰岩層準の分布域、地層の走向、褶曲等と一致しているように見える。各調査法による異常域の分布をまとめ、それを第I—V帯に区分してFig V-1, Table V-1, V-2に図示した。

第I帯はmetasedimentary rockよりなりこの異常域の南東延長部には銅の鉱徴が認められる。

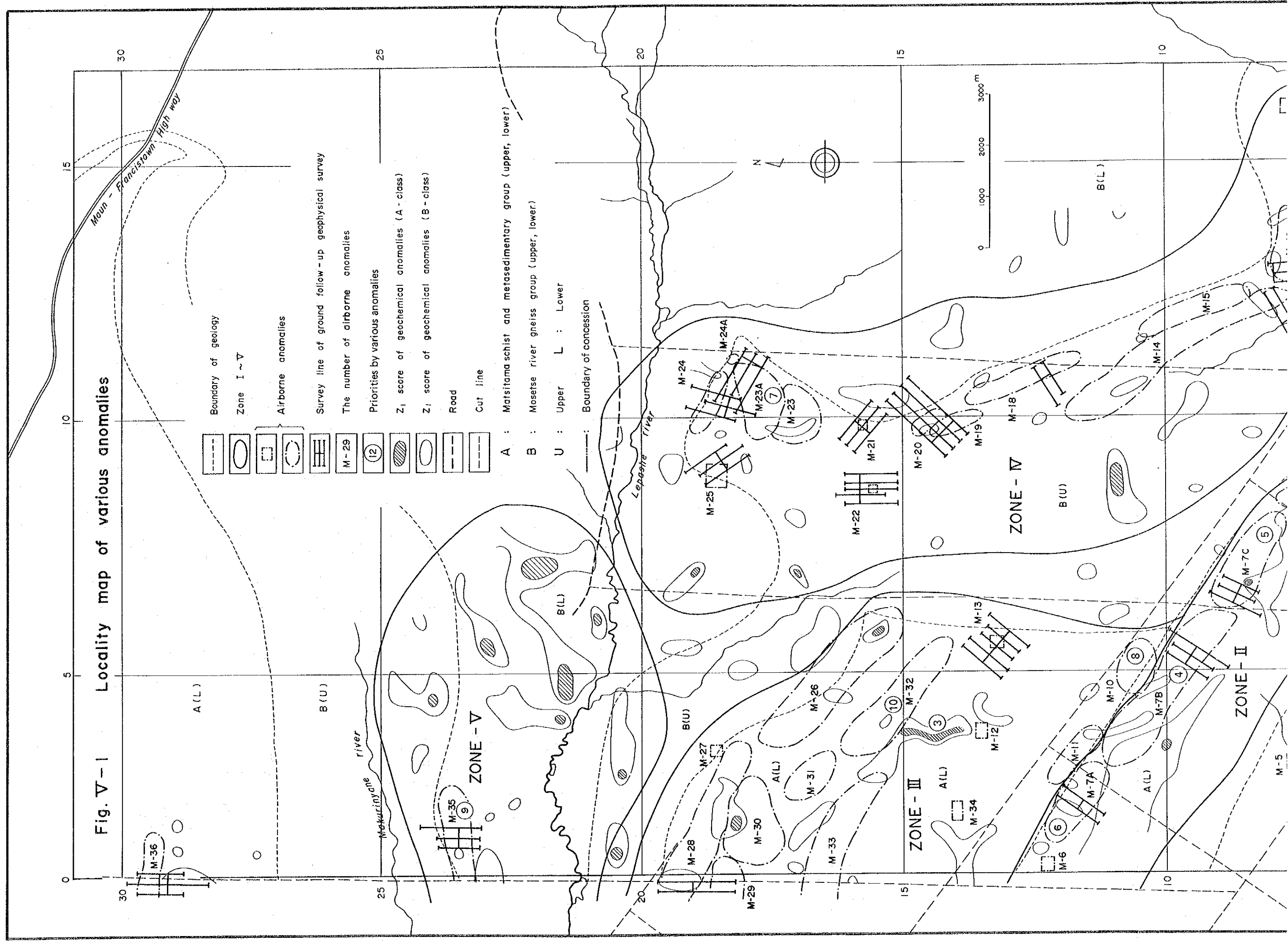
第II帯は石灰岩薄層をはさむmetasedimentary rockよりなるが地表には見るべき銅の鉱徴はない。

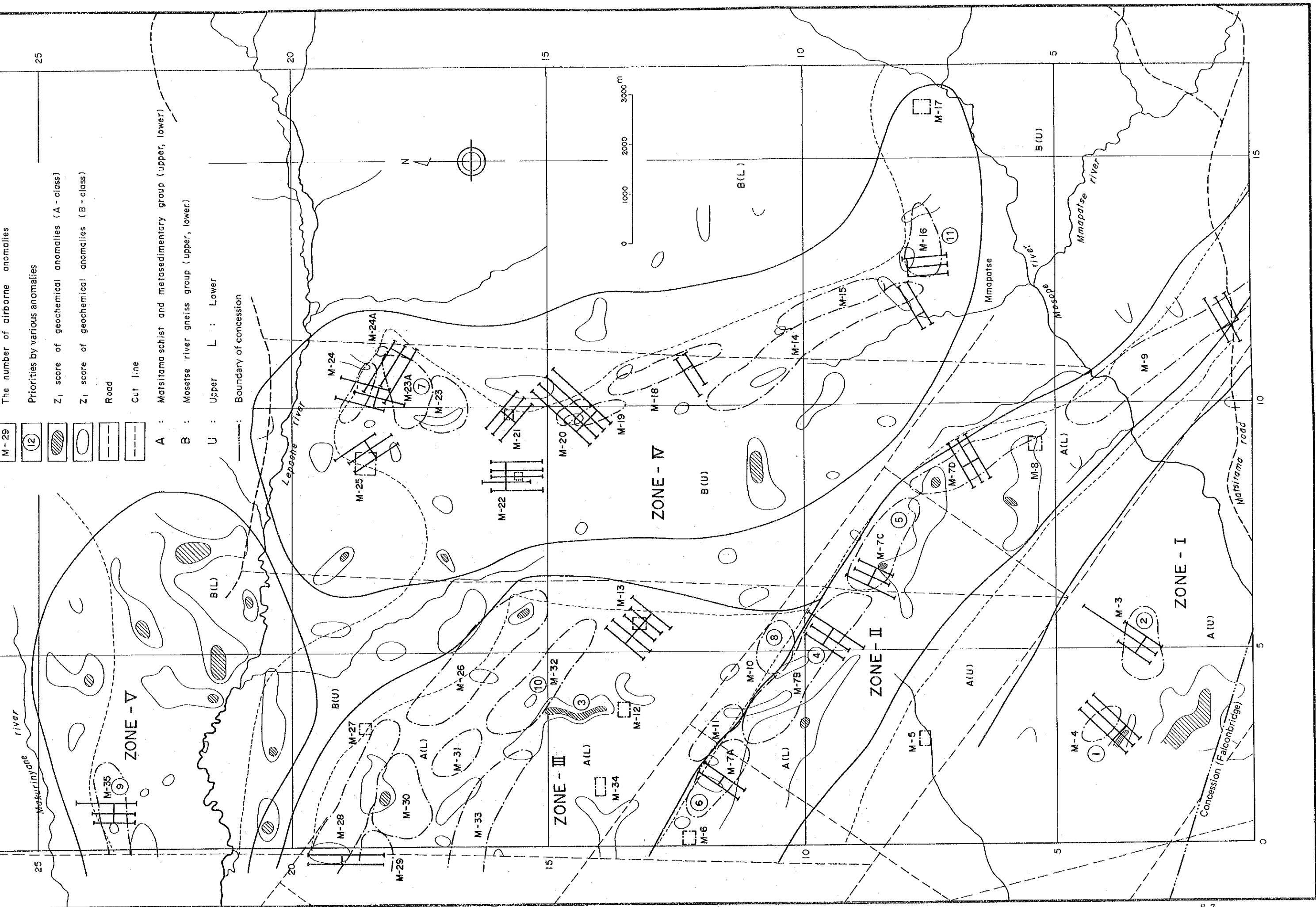
第III帯は第II帯が断層により転移したブロックで第II帯同様metasedimentary rockの分布が見られる。地化学探査の結果では一般に銅品位が高いが、地表に銅の鉱徴は認められない。本帯北西端において、石ぼくを含む疑いのある黒雲母片岩の小転石(S-127)が見られたが、現段階では石ぼくの存在は確認していない。また本帯中には往時の試鉱探鉱跡2箇所が認められた。

第IV帯はcalcrete—角閃片岩—石灰岩層準の分布とほぼ一致し、その褶曲頂部に物理探査異常が見られた。しかし地表調査、地化学探査の結果からは銅の鉱徴を認めることが出来なかった。

第V帯は塩基性岩、超塩基性岩の転石が卓越する帯で、磁気探査結果より塩基性岩脈の密集区域と推定される。地化学探査の結果では他帯より高い鉛品位が得られたが、鉛の鉱徴は認め

Fig. V-1 Locality map of various anomalies





The number of airborne anomalies

Priorities by various anomalies
 Z₁ score of geochemical anomalies (A - class)
 Z₁ score of geochemical anomalies (B - class)

Road
 Cut line

A : Matsitama schist and metasedimentary group (upper, lower)
 B : Moseitse river gneiss group (upper, lower)
 U : Upper L : Lower

Boundary of concession

Table V-1 List of various anomalies with interpretation

Selected conductors by airborne geophysical survey		Geological survey (G.S.)			Geochemical Survey (G.C.)			Ground follow-up geophysical survey (G.G.)				Recommendation			
Anomaly	Location	Geology	Mineralization	Position	Soil	Max. value in ppm (Cu)	P.C.M. result	Conductor	Polarizable	Magnetic association	Probable primary source	G.S.	G.C.	G.G.	Priority
M-2	X6-7		out of survey area					Multiple bed rock	Yes	No	Graphite	-	-	X	
	Y0-1	A (U)	Cu showing	4	1.2	521	⊙	Bed rock	Yes	No	Sulphide	⊙	⊙	⊙	2
M-3	X4-6	A (U)	Cu showing	4	1.2	565	⊙	Bed rock	Yes	No	Sulphide	⊙	⊙	⊙	1
M-4	X3-4	A (L)	-	4	2.3	90	⊙	Multiple bed rock	Yes	Yes	Graphite	○	○	○	6
M-7A	X2-3	A (L)	-	4	2.3	87	⊙	Bed rock	Yes	No	S + G	○	○	⊙	4
M-7B	Y11-12	A (L)	-	4	1.2,3	272	⊙	Bed rock	Yes	No	S + G	⊙	⊙	⊙	5
M-7C	X6-8	A (L)	-	4	1.2	175	⊙	Bed rock	Yes	No	Graphite	⊙	⊙	X	
M-7D	Y7-9	A (L)	-	4	1.2,3	77	○	Bed rock	Yes	No	Graphite	○	○	X	
M-9	X8-10	A (L)	-	4	1.2,3	69	○	Multiple bed rock	Yes	No	S + G	○	○	○	8
M-10	Y0-5	A (L)	-	4	1.2,3	187	○	?	-	?	?	○	○	○	3
near M-13	X5-6	A (L)	Cu showing	4	1.2	62	○	Bed rock	Yes	No	Graphite	○	X	X	
M-14	Y13-14	B (U)	-	4	1.2,3	50	⊙	Multiple bed rock	Yes, ?	No	Graphite	⊙	○	○	11
M-16	X12-14	B (U)	-	4	1.2	51	X	Bed rock	Yes	No	Graphite	X	○	X	
M-18	X10-11	B (U)	-	4	1.2	48	○	Bed rock	Yes	No, ?	Graphite	○	○	X	
M-19/20	Y12-14	B (U)	-	4	1.2	53	○	Bed rock	Yes	Yes, ?	Graphite	X	○	X	
M-21	X9-10	B (U,L)	-	4	1	42	X	Surficial?	No	No	-	X	X	X	
M-22	Y15-16	B (U)	-	-	1.2	53	○	Multiple bed rock	Yes	Yes	Graphite	○	○	○	
M-23	X9-11	B (U)	-	4	1.2	52	○	Bed rock	Yes	Yes	Graphite	○	○	○	7
M-23A	Y17-18	B (U,L)	-	4	1.2	47	○	Bed rock	Yes	No	Graphite	○	○	X	
M-24	X11-12	B (U,L)	-	4	1.2	47	○	Bed rock	Yes	Yes, ?	Graphite	○	○	X	
M-25	Y18-19	B (U,L)	-	4	1.2	47	○	Bed rock	Yes	Yes, ?	Graphite	○	○	X	
M-28	X1-4	A (L)	-	4	2,3	62	⊙	Bed rock	Yes	Yes, ?	Graphite	○	○	X	
M-29	Y18-20	A (L)	-	4	1.2	31	○	Bed rock	Yes	Yes, ?	Graphite	○	○	X	
M-35	X1-3	B (U,L)	-	4	1.2	56	○	Multiple bed rock	Yes	No	S + G	○	○	○	9
M-36	Y23-24	A (L)	-	4	1.2	-	-	Bed rock	Yes	No	Graphite	○	X	X	
M-5	X3-4	A (U)	-	4	3	-	-	-	-	-	-	-	-	-	
M-6	Y7-8	A (L)	-	4	2	65	○	-	-	-	-	-	-	-	
M-8	X1-2	A (L)	-	4	2	87	⊙	-	-	-	-	X	⊙	-	
M-11	Y12-13	A (L)	-	4	1.2,3	103	○	-	-	-	-	○	○	-	
M-12	X3-4	A (L)	-	4	1.2	130	⊙	-	-	-	-	⊙	⊙	-	
M-15	Y13-14	B (U)	-	4	1.2,3	56	○	-	-	-	-	○	○	-	
M-17	X8-10	B (U)	-	4	?	-	-	-	-	-	-	○	○	-	
M-17	Y16-17	B (U)	-	4	?	-	-	-	-	-	-	○	○	-	
M-27	X3-4	A (L)	-	4	2	37	○	-	-	-	-	○	X	-	
M-30	Y18-19	A (L)	-	4	1.2	62	⊙	-	-	-	-	⊙	○	-	
M-31	X2-4	A (L)	-	4	1.2	144	○	-	-	-	-	○	○	-	
M-32	Y16-18	A (L)	-	4	1.2	156	⊙	-	-	-	-	⊙	○	-	10
M-33	X3-6	A (L)	-	4	1.2	115	○	-	-	-	-	○	○	-	
M-34	Y15-17	A (L)	-	4	1.2	54	X	-	-	-	-	○	○	-	
	X2-3	A (L)	-	-	2	-	-	-	-	-	-	○	⊙	-	
	Y14	A (L)	-	-	-	-	-	-	-	-	-	○	○	-	

Note:

1. M-1, M-1' Out of the survey area. Checking known Matsitama deposits. Data are not listed on the table.
2. M-37, M-38, M-39, M-40, M-41 are minor conductors and have no priority. Data are not listed on the table.
3. Abbreviation

A: Matsitama schist and metasedimentary group (upper, lower)

B: Moese river gneiss group (upper, lower)

U: Upper, L: Lower

Soil 1: brown soil, 2: brown grey soil, 3: dark brown soil

Position 4: in and close to calcrete

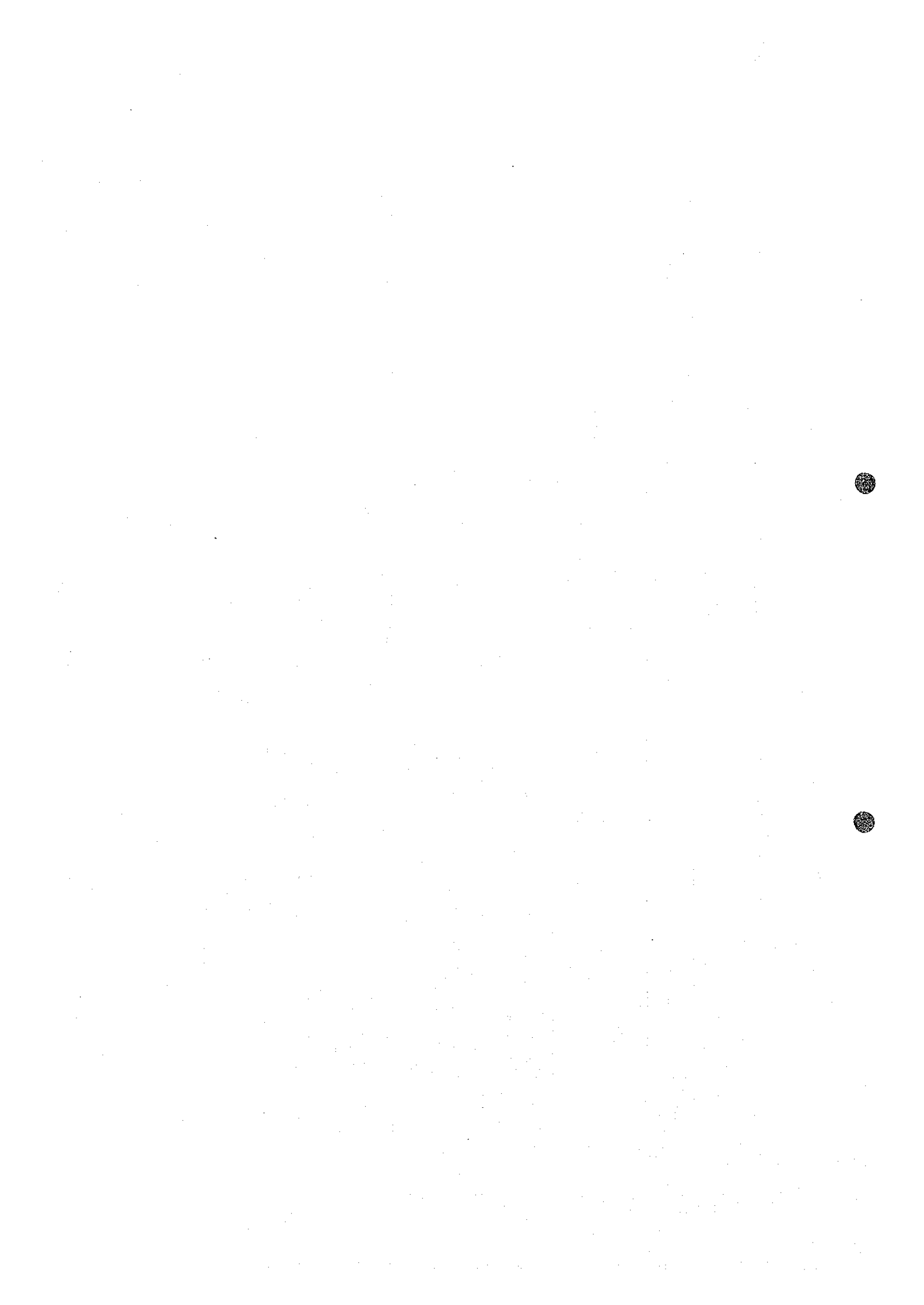
S: Sulphide

G: Graphite

Table V-2. List of the priority on various anomalies after analysis

Zone	Anomalies in the zone	Priority of anomaly	Note	Priority of zone
I	M-4, M-3	1, 2	Medium Cu anomaly (soil). Strong conductivity, without magnetic association in bed rock	1
II	M-7B, M-7C, M-7A, M-7D, M-9 (M-6), (M-8)	4, 5, 6	Medium Cu anomaly (soil)	2
III	M-13, M-10, M-32, M-28, M-29 (M-11), (M-12), (M-27), (M-30), (M-31), (M-33), (M-34)	3, 8, 10	Weak Cu anomaly (soil)	3
IV	M-23A, M-16, M-14, M-18, M-19/20 M-21, M-22, M-23, M-24, M-25 (M-15), (M-17)	11, 7	Weak Cu anomaly (soil)	4
V	M-35	9		5

- Notes:
1. The number of anomaly in parenthesis has low priority of the anomaly.
 2. M-2, M-5, M-36 are not listed in the table. M-2 is out of surveyed area, while M-5, M-36 are isolated anomalies.



られなかった。また本帯には銅の鉱徴も認められなかった。なお、クロマイトの鉱徴を本帯で確認した。

物理探査では異常の原因の1つとして石ぼくを考えている。しかし、地質調査の結果地表では石ぼくを含む疑いのある岩石は第Ⅲ帯の西北端でわずかに認められただけであった。また調査地域内には石ぼくまたは石ぼく片岩と関係のほとんどないMatsitama型の変堆積性鉱床の存在が予想される。また剪断帯沿いに銅 — 石ぼくの濃集するBushman型の鉱化の期待は地表で見ると限り薄い。従って、ほとんどのPulse EMの異常の原因が石ぼくとなっている点については、地表で見ると限りでは地質的には疑問がある。



第VI部 結論および提言

以上の調査結果得られた異常域を総合し、それを Table V - 1 に取りまとめた。

異常域は調査地域内の地化学探査実施地域内に集中した。それは5帯に大別され、最北端の第5帯を除き何れもほぼNW-S Eの走向を持ち、地層の分布とほぼ整合的に分布する。

各異常帯の評価に当たり最も問題になったのは、石ほくと鉍化作用の関係である。本調査地域に於いて、鉍床の賦存する可能性は、Bushman 鉍床型よりも Matsitama 鉍床群型の方が高いものとして解析を行った。

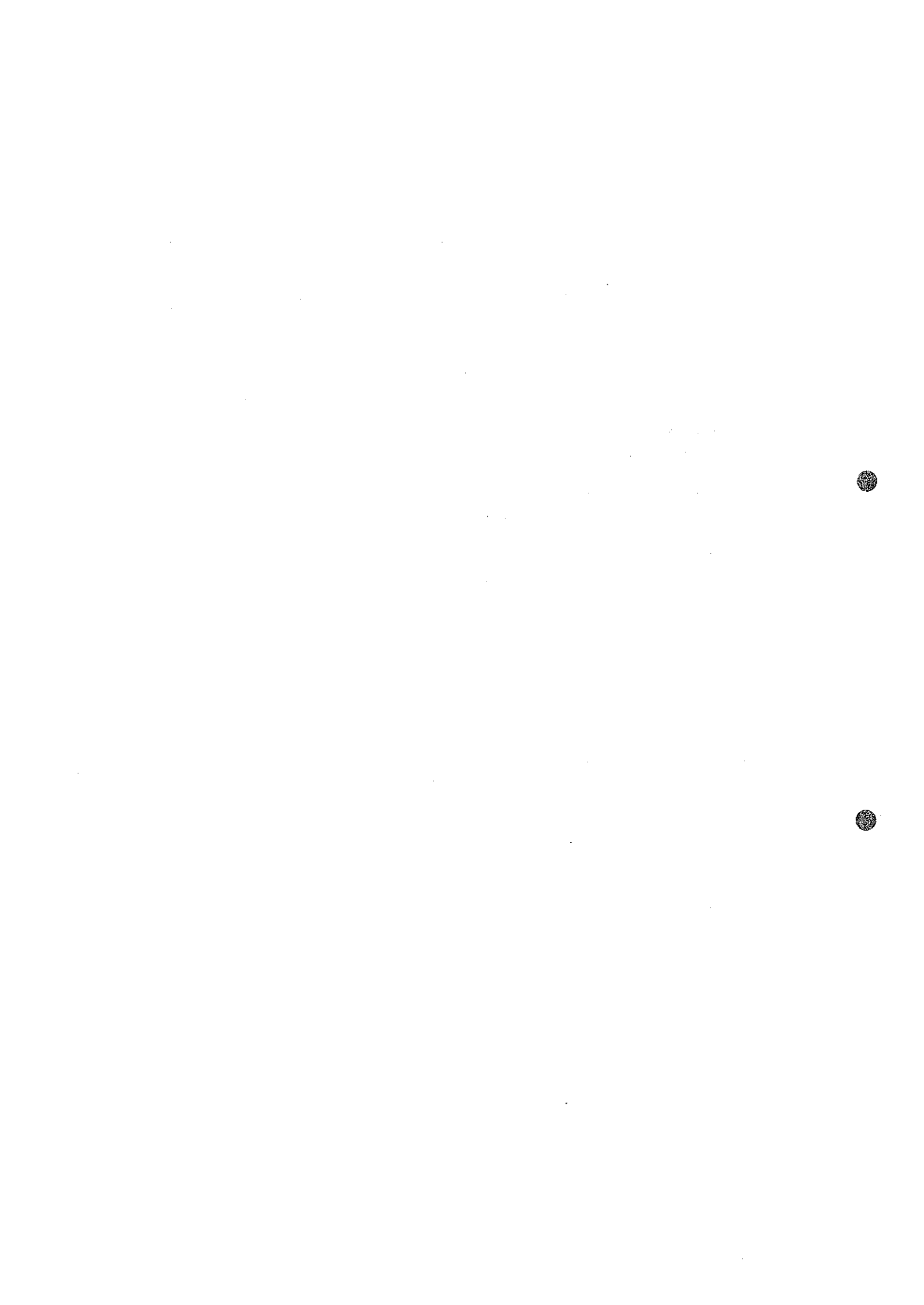
その結果、銅を主体とする鉍床を対象とする場合、南西端の第I帯が最も有望と判定され、次いで第II、第III、第IV帯の各帯の順で今後の探鉍の価値があるものと判定した。

最北端の第5帯は、後述のクローム鉍徴を持つほかに地化学探査主成分分析法解析の結果一応の異常が検出された(鉛の異常による点が多い)。しかしこれは地質、物理探査の異常とは一致せず、農道、農園沿いの異常でもあり、二次的汚染も考えられるため、今後の銅の探査地域から除外した。

第III年次に於いては、地上および空中物理探査で抽出された異常地域のうち、地化学探査異常帯に含まれる異常域を次の順、M-4, M-3, M-13附近, M-7B, M-7C, M-7A, M-23A, M-10, M-35, M-32, M-16で試錐探査を実施することが望ましい。

地層の傾斜が一般に南傾斜であること、また地上物理探査の Pulse E.M. 法および I.P. 法の異常の検出範囲が地表下30m程度であることなどから判断して、試錐は垂直孔で地表下30~60m程度を着鉍予 positioning とし、1孔当りの深度は100m程度が望ましい。

上述した調査地域南西部を主体とした銅鉍徴の他に、調査地域北西部第5帯で今回発見された塊状クロマイト鉍徴地についても、浅尺試錐を含む地質精査の実施を提言する。それと同時に本鉍徴の南西約10kmの Lepashe 地区に存在が報告されているクロマイト鉍徴地も含めて地質調査の必要がある。

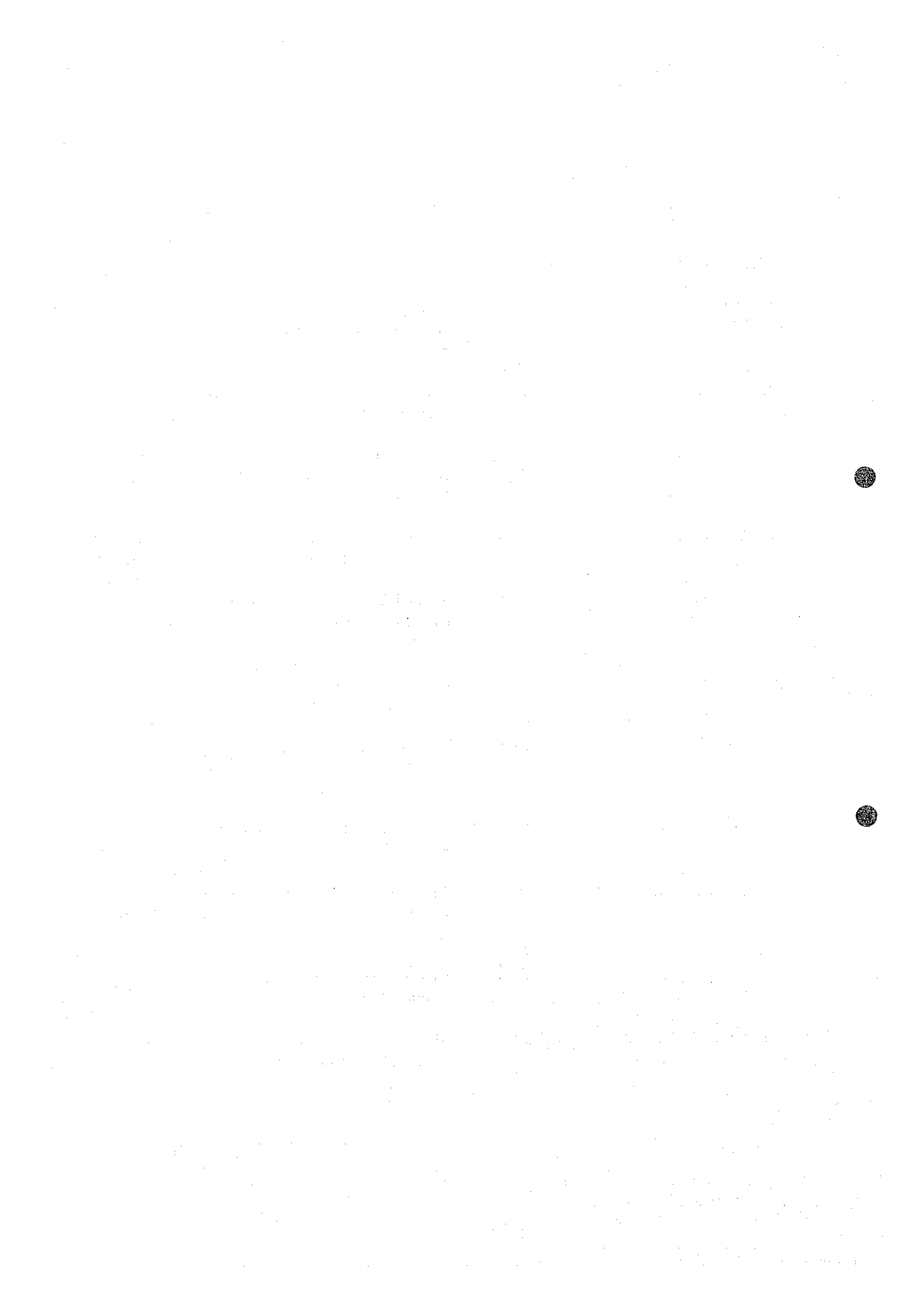


参 考 文 献

References

Geological and Geochemical Survey

- (1) Baldock J.W. et al 1977 Resources inventory of Botswana; metallic minerals, mineral fuels and diamonds, Mineral Resources Report No. 4, Geol, Surv. Bots.
- (2) Bennett, J.D. 1970 Geological map of Mosetse-Matsitama area, Geol. Surv. Bots.
- (3) Durey, H.J. 1974 Report on the exploration of the Mapatsi area, January to September 1974. Unpublished BCL report.
- (4) Durey, H.J. 1974 Report on the exploration of Mosupe area. Unpublished BCL report.
- (5) Lepeltier, C 1969 A simplified statistical treatment of geochemical data by graphical representation, Econ. Geol. Vol. 64. p.p. 538 – 550
- (6) Lintern, B.C. 1973 Report on the copper deposits of Bushman area. Unpublished BCL report.
- (7) Litherland, M. 1975 The geology of the area around Maitengwe, Sebina and Tshesebe, northeast and central districts, Botswana. Geol. Surv. Bots.
- (8) MMAJ and JICA 1980 Report on geological survey of the northeastern Botswana. Phase I.
- (9) Stansfield, G. 1973 The geology of the area around Dukwe and Tlalamabele, central district, Botswana Geol. Surv. Bots.
- (10) Strugnell, S.R. 1974 Final report Bushman regional area, May 1972 to June 1974
- (11) Suwa, K., Yairi, K. 1979 Africa, "Earth Science", Vol. 16, Geology of the world. Iwanami (in Japanese)



Geophysical Survey

- (1) Palacky, G.J. and West, G.W. 1973 Quantitative interpretation of INPUT AEM measurements geophysics, Vol. 38, p.p. 1145 – 1158.
- (2) Palacky, G. J 1975 Interpretation of INPUT AEM measurements in area of conductive overburden, Geophysics, Vol. 40, p.p. 490 – 502.
- (3) Hahn, A., Kind, E.G. and Mishra, V.S. 1976 Depth estimation of magnetic sources by means of fourier amplitude spectra, Geophysical Prospecting, Vol. 24, p.p. 287 – 308.
- (4) Baramov, V. 1957 A new method for interpretation of aeromagnetic maps Psevdo-gravimetric anomalies, Geophysics, Vol. 22, p.p. 359 – 383.
- (5) Legault, M. 1980 Interpretation report airborne electromagnetic survey BARRINGER INPUT system of the MATSITAMA NORTH AREA, REPUBLIC OF BOTSWANA. Geoterrex limited.
- (6) Keeler, K.R. 1980 Ground follow-up geophysical surveys under taken near MATSITAMA, REPUBLIC OF BOTSWANA. Geoterrex limited.



卷末附圖附表

List of microscopic observation

Sample No.	Sample Location		Rock	Mineral																								Texture	Geology	Note												
	X	Y		q	kf	pl	mus	bi	hb	act	hyp	cpx	mt	chr	ap	zr	sph	ca	do	si	ep	chl	mont	ser	serp	gar	lm				rt	hm	ta	py	try	cha	mal	ol	qr			
S- 1	3.2	34.5	Aplitic granite	•	o	•	Δ	x													x		Δ																holo	B(L)		
2	5.4	35.7	Dolerite			•				•	o										x	o																	suboph	Dolerite dyke		
3	6.4	34.4	Monzonite		•	•		Δ						x		Δ					Δ																		holo	B(L)		
4	6.5	32.9	Amphibole schist	x		•		•													Δ	•					Δ												sch	B(U)		
5	10.2	34.8	Amphibole schist	Δ		•		x	•					x							Δ	Δ					Δ												sch	B(L)		
6	10.5	34.3	Granite gneiss	•	o	•	Δ	o						x		x					o	o																	gne	B(L)		
7	10.8	33.4	Granite gneiss	o	o	•								x		x					•	•					x												gne	B(L)		
8	11.7	31.5	Amphibole schist	o				•													Δ	Δ			Δ	Δ													sch	A(L)	1764 ± 88 m.y.	
9	12.2	30.5	Granite gneiss	•	o	•	o	x						x		x					x	x		Δ			x												gne	A(L)		
10	14.4	33.9	Granite gneiss	•	•	•	Δ	Δ													Δ	Δ		x															holo, gne	B(L)		
11	14.3	33.6	Aplitic granite		•	•								x		x	Δ				Δ	x				x													holo	Granite dyke		
12	17.0	29.9	Amphibole schist			•		•				Δ		x							o	Δ					Δ												sch	B(L)		
13	17.3	29.0	Porphyroblastic gneiss	•	•	•		o						x		x	x				Δ	Δ																	gne	B(L)		
14	24.9	27.4	Porphyroblastic gneiss	•	•	•	Δ	Δ						x		x	x				Δ	o																	gne	B(L)		
15	1.1	23.5	Limestone							trm											•	Δ					Δ												mos	B(L)	trm: tremolite	
16	1.3	21.9	Hornblende granite gneiss	o	o	•		Δ						x		x					Δ	Δ				x													gne	B(L)		
17	1.2	21.2	Granite gneiss	•	•	•	Δ	Δ				Δ		x							x	Δ		x		x	x												gne	B(L)		
19	2.2	19.0	Biotite schist	•				•													x				x		o			Δ									sch	A(L)		
20	2.7	17.8	Quartzite	•		•	o															Δ				x														A(L)		
21	3.5	25.2	Serpentinite									Δ												•																		
23	4.0	24.0	Chromite										•									•																				
26	4.3	21.2	Granite gneiss	•	•	•	Δ	Δ				Δ									x	x			x	x													gne	B(L)		
27	4.6	21.0	Granite gneiss	•	•	o		Δ													x	x				x														gne	B(L)	
28	4.6	20.3	Amphibole schist	o		•		•						x																										sch	B(U)	
29	4.6	20.2	Epidotized rock	•				Δ						x		Δ	Δ				•	Δ			Δ															B(U)		
30	5.0	25.4	Chromite									•										•				Δ														B(U)	Cr ₂ O ₃ 37.8%	
31	5.4	24.1	Serpentinite								o													•		Δ			Δ													
33	5.3	24.0	Chromite									•										•																				

Sample			Rock	Mineral																							Texture	Geology	Note																
No.	Location			q	kf	pl	mus	bi	hb	act	hyp	epx	mt	chr	ap	zr	sph	ca	do	si	ep	chl	mont	ser	serp	gar				lm	rt	hm	ta	py	try	cha	mal	ol	qr						
	X	Y																																											
66	6.3	6.5	Feldspathic quartzite	•	Δ	•	○													•		x		x																A(L)					
67	6.5	3.3	Feldspathic quartzite	•	○	•	○														•		x		x															A(U)					
68	6.4	2.0	Quartz schist	•		○															Δ						Δ									Δ				sch	A(U)	Cu 5.2%			
69	6.5	1.4	Biotite schist	x	•			•	Δ				Δ		x						Δ																			sch	A(U)				
70	7.9	8.5	Quartzite	•			Δ	x				Δ																													sch, cat	A(L)			
71	7.1	2.8	Quartz muscovite schist	•		○	○														•		x		x			x	○							Δ				sch, amy	A(U)				
72	7.0	2.2	Quartz muscovite schist	•		○	○														Δ							Δ	○												sch	A(U)			
73	7.1	1.6	Chlorite schist	•		○	Δ										x				•		x				Δ	x	Δ												sch	A(U)			
74	7.7	1.7	Amphibole schist	○		Δ			•												○								Δ	x												sch	A(L)		
75	8.5	6.5	Calcareous quartz schist	•							x							•			Δ							Δ														sch	A(L)		
76	8.4	2.8	Chlorite schist	•		○	Δ														•							x	○													sch	A(U)		
77	8.7	3.0	Amphibole talc schist	•		•		x	○				Δ		x					x		Δ					x	x		○												sch	A(L)		
78	8.4	2.9	Chlorite schist	○											x						•							x	Δ													sch	A(U)		
80	8.4	2.4	Limestone	Δ		Δ			Δ									•												Δ	○											mos	A(U)	Trench, Malachite	
81	8.4	2.0	Garnet bearing rock	Δ		Δ			Δ			x					○				Δ					•			Δ	Δ						Δ					mos	A(U)			
94	8.0	1.8	Quartz schist	•		Δ						Δ						x										Δ														sch	A(U)		
95	9.5	7.1	Quartzite	•																								Δ		•													B(U)		
96	9.9	3.5	Chlorite schist	•		○									x						Δ		•					Δ														sch	A(L)		
97	10.5	4.2	Feldspathic quartzite	•		•						x		x				Δ			Δ		Δ				○															cat?	B(U)		
98	10.5	3.9	Limestone	Δ														•																								mos	A(L)		
99	10.6	4.3	Quartz feldspar schist	•		•		Δ																				x	x													sch	B(U)		
100	11.9	9.5	Phyllite	Δ				Δ																				○			Δ	Δ										ban	B(U)		
101	12.5	9.5	Amphibolite						•			Δ									•						x			○												gran	B(L)		
102	12.4	9.0	Serpentinite						•	Ant									Δ			○					x			•													B(U)	Ant: Anthophyllite	
103	12.8	9.5	Amphibole schist	•		•			○					Δ							•		x	Δ					Δ														sch	B(U)	
104	12.4	5.4	Granite gneiss	•	•	•	Δ	○				Δ		x				x		x	Δ		x																			gne	B(U)	1837 ± 92 m.y.	
105	13.7	9.0	Actinolite schist			•	Δ			•		Δ									Δ							Δ														sch	B(L)		
106	13.1	8.0	Altered ultrabasic rock (?)	Δ			Δ			•		○							Δ								x	x														gne	B(U)		
107	14.8	6.9	Granite gneiss	•	○	○		Δ	Δ					Δ								Δ																					gne	B(U)	

Sample			Rock	Mineral																								Texture	Geology	Note												
No.	Location			q	kf	pl	mus	bi	hb	act	hyp	cpx	mt	chr	ap	zr	sph	ca	do	si	ep	chl	mont	ser	serp	gar	lm				rt	hm	ta	py	try	cha	mal	ol	qr			
108	14.7	6.0	Granodiorite gneiss	•	o	•		o							Δ	x					x		x																	gne	B(U)	
109	14.4	4.5	Granodiorite gneiss	•	o	•		o				Δ		Δ	x	x					x	x		x																gne	B(U)	
110	14.8	7.2	Amphibole schist	o		o	Δ		•												x	Δ		x				Δ												sch	B(U)	
111	16.9	7.9	Hornblende granite gneiss	•	•	•		o						Δ	x						Δ		•		Δ														gne	B(U)		
112	16.7	7.9	Amphibole schist	Δ		•		•														x					Δ													sch	B(U)	1755 ± 88 m.y.
113	17.0	7.8	Actinolite schist			•		o											x	x	Δ		x																sch	B(U)		
114	16.7	7.6	Serpentine										o									Δ		•												Δ						
115	16.5	2.1	Granite gneiss	•	•	o	Δ	Δ	Δ					Δ	Δ	Δ					Δ	Δ		Δ															gne	B(U)		
116	18.8	10.7	Amphibole schist			•		•						x								o						Δ												sch	B(L)	
117	17.9	10.2	Amphibole schist	o		o		•					x	x							x	Δ					x	Δ												sch	B(L)	
118	19.9	11.6	Gabbro			•					•	o											o																holo, suboph	Gabbro dyke		
119	20.6	15.5	Granite gneiss	•	•	o	Δ	Δ				Δ		Δ	x						x	Δ		Δ															gne	B(L)		
120	20.5	14.0	Amphibole schist	Δ		•		x	•					x							x	Δ		x				Δ												sch	B(L)	
121	20.9	7.6	Granodiorite gneiss	•	o	•						Δ																												gne	B(L)	
122	20.8	1.9	Amphibole schist	o		•		x	•					x		Δ						Δ					x													sch	B(U)	
123	21.4	2.1	Granodiorite gneiss	•	o	•	Δ	Δ														Δ		Δ																gne	B(U)	
124	22.3	17.2	Porphyroblastic gneiss	•	•	o		o				Δ		x	x	Δ					Δ	Δ																		gne, Prop.	B(L)	
125	22.9	7.2	Amphibole schist	Δ		•		•			o			x							Δ	Δ						Δ												sch	B(L)	
126	24.6	11.9	Granite gneiss	•	•	o	Δ	Δ				Δ		x	x						Δ	Δ		x																gne	B(L)	
128	Makala deposit		Calcareous mica quartz schist	•		Δ	o	o																		Δ													sch	A	Waste of adit	
129	Makala deposit		Muscovite quartz schist	•		o	•	Δ						x			Δ				Δ						x												sch	A	Waste of adit	
130	Thakadu deposit		Biotite quartz schist	•		Δ		•						x			o				Δ																		sch	A	Waste of adit	

Abbreviation:

Mineral					
q	quartz	ap	apatite	gar	garnet
kf	potash feldspar	zr	zircon	lm	limonite
pl	plagioclase	sph	sphene	rt	rutile
mus	muscovite	ca	calcite	hm	hematite
bi	biotite	do	dolomite	ta	talc
hb	hornblende	si	siderite	py	pyrite
act	actinolite	ep	epidote	try	tridymite
hyp	hyperthene	chl	chlorite	cha	chalcedony
cpx	clinopyroxene	mont	montmorillonite	mal	malachite
mt	magnetite	ser	sericite	ol	olivine
chr	chromite	serp	serpentine	gr	graphite

Texture	
holo	holocrystalline
suboph	subophitic
gran	granular
sch	schistose
gne	gneissose
mos	mosaic
ban	banded
cat	cataclastic
amy	amygdaloidal

Symbol	
•	abundant
o	common
Δ	rare
x	very rare

A : Matsitama schist and metasedimentary group (upper, lower)

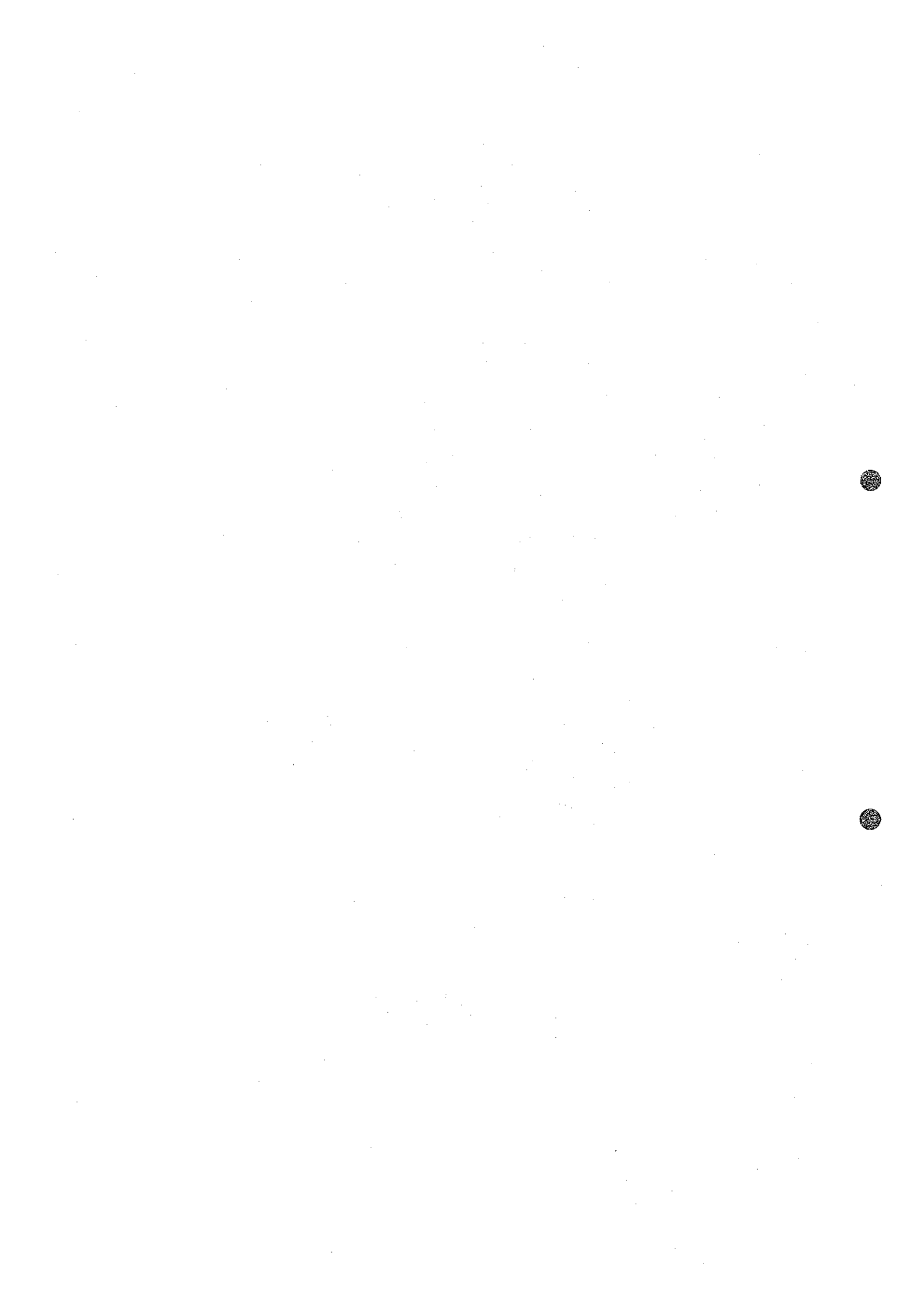
B : Mosetse river gneiss group (upper, lower)

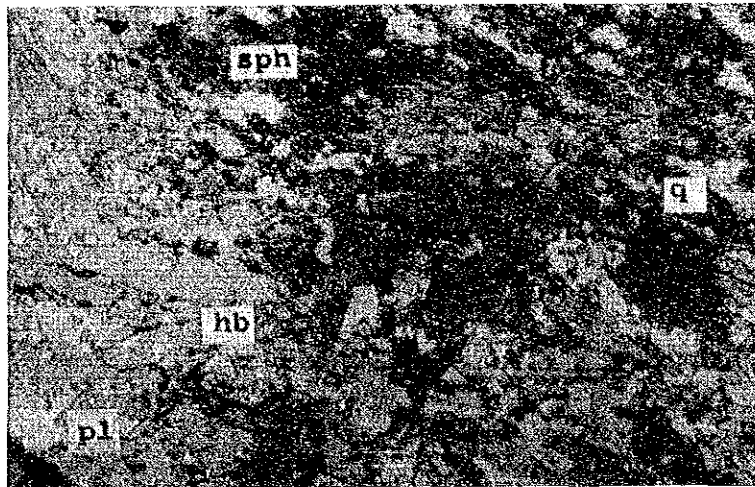
U : Upper , L : Lower

Apex. 2. Microphotographs

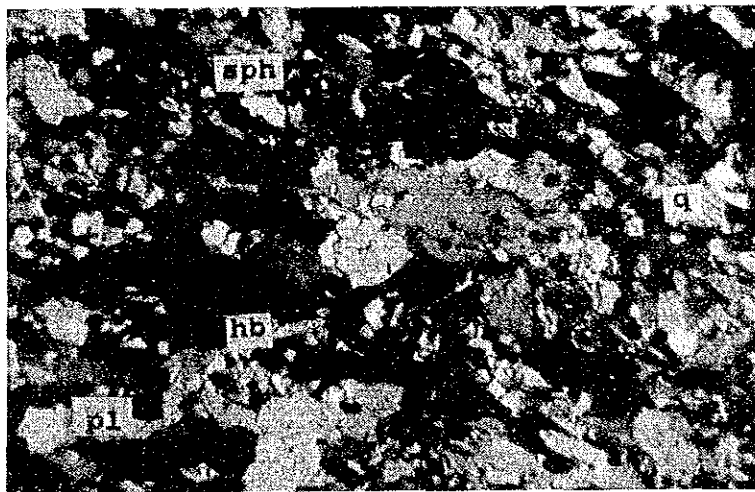
q:	quartz	hm:	hematite
or:	orthoclase	chr:	chromite
pl:	plagioclase	mal:	malachite
bi:	biotite	ca:	calcite
mus:	muscovite	ser:	sericite
hb:	hornblende	eq:	epidote
sph:	sphane	chl:	chlorite
gar:	garnet	serp:	serpentine
mt:	magnetite	ta:	talc

All microphotographs except S-34 (2b) are those of thin sections. S-34 (2b) is that of polished section.





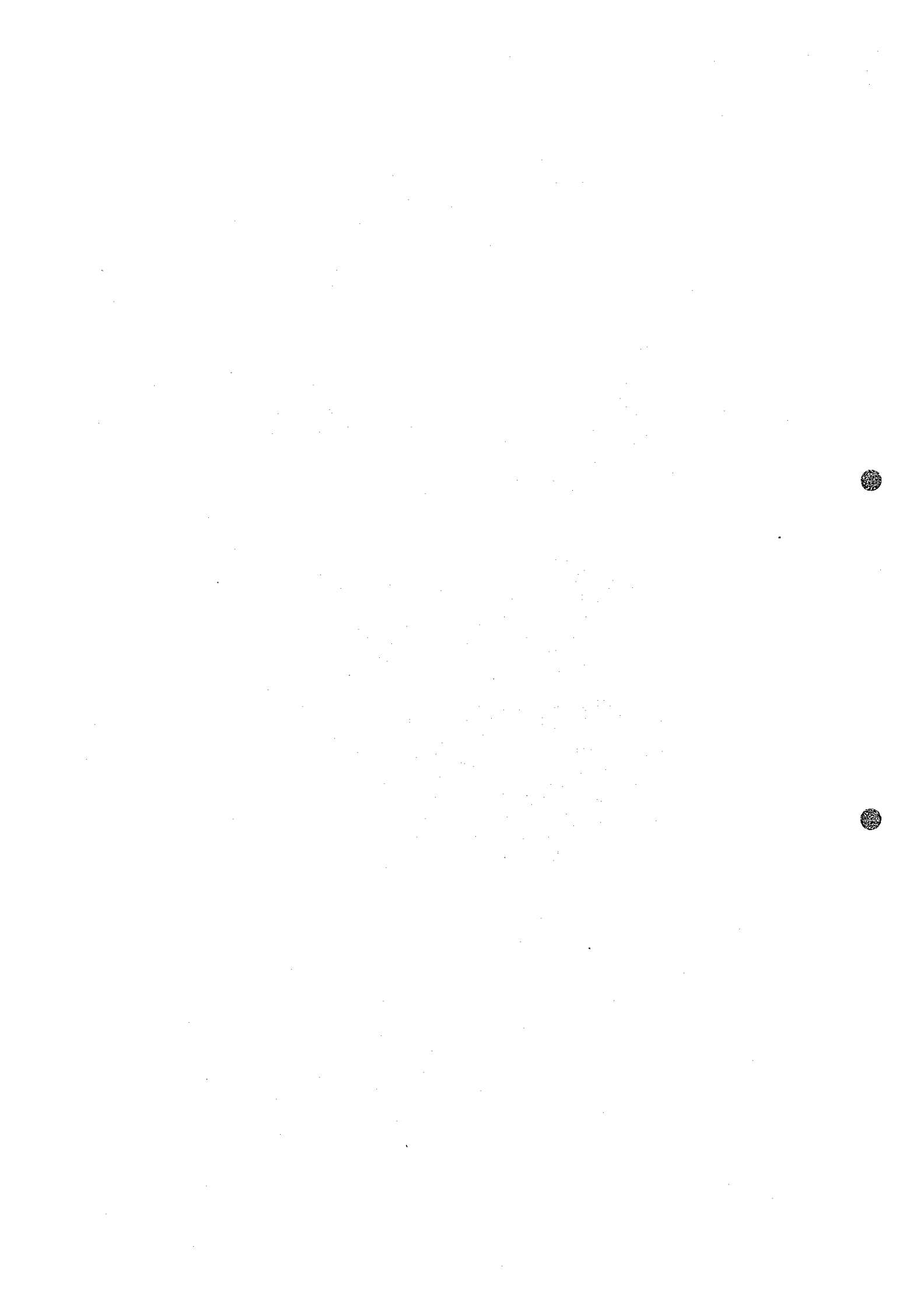
1a S-8 Amphibole schist – Open nicol

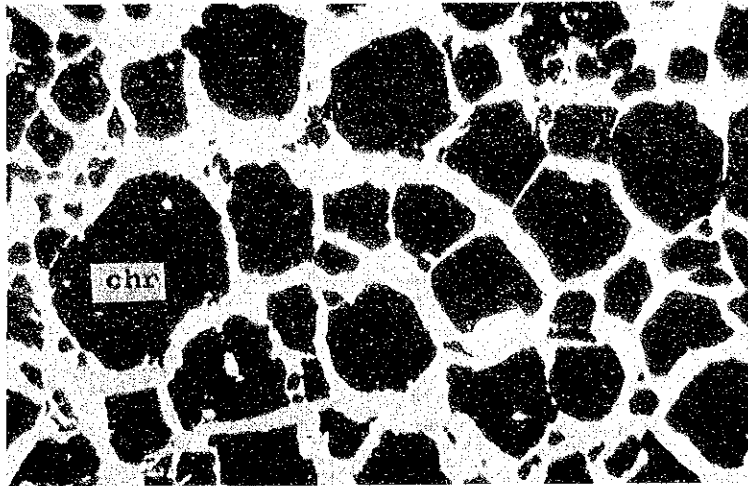


1b Same as the above – Crossed nicols

0 0.5mm

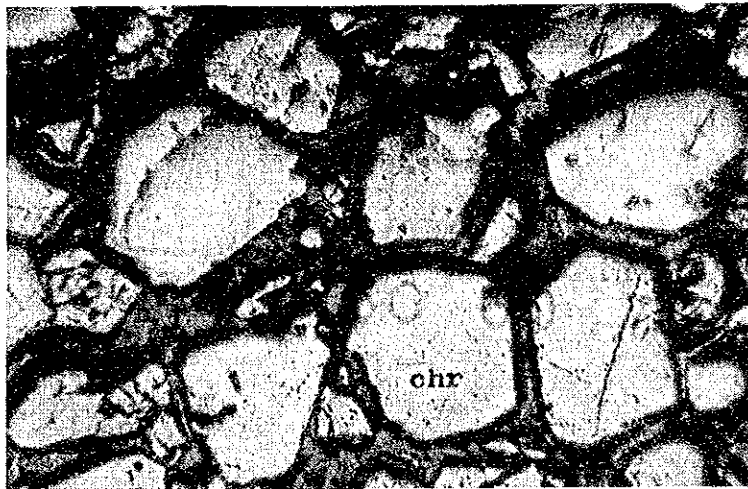
Sample for dating: 1764 ± 88 m.y. Fresh. Weak alteration (sericite, epidote, chlorite)





2a S-34 Chromite ore – Opennicol

0 0.5mm



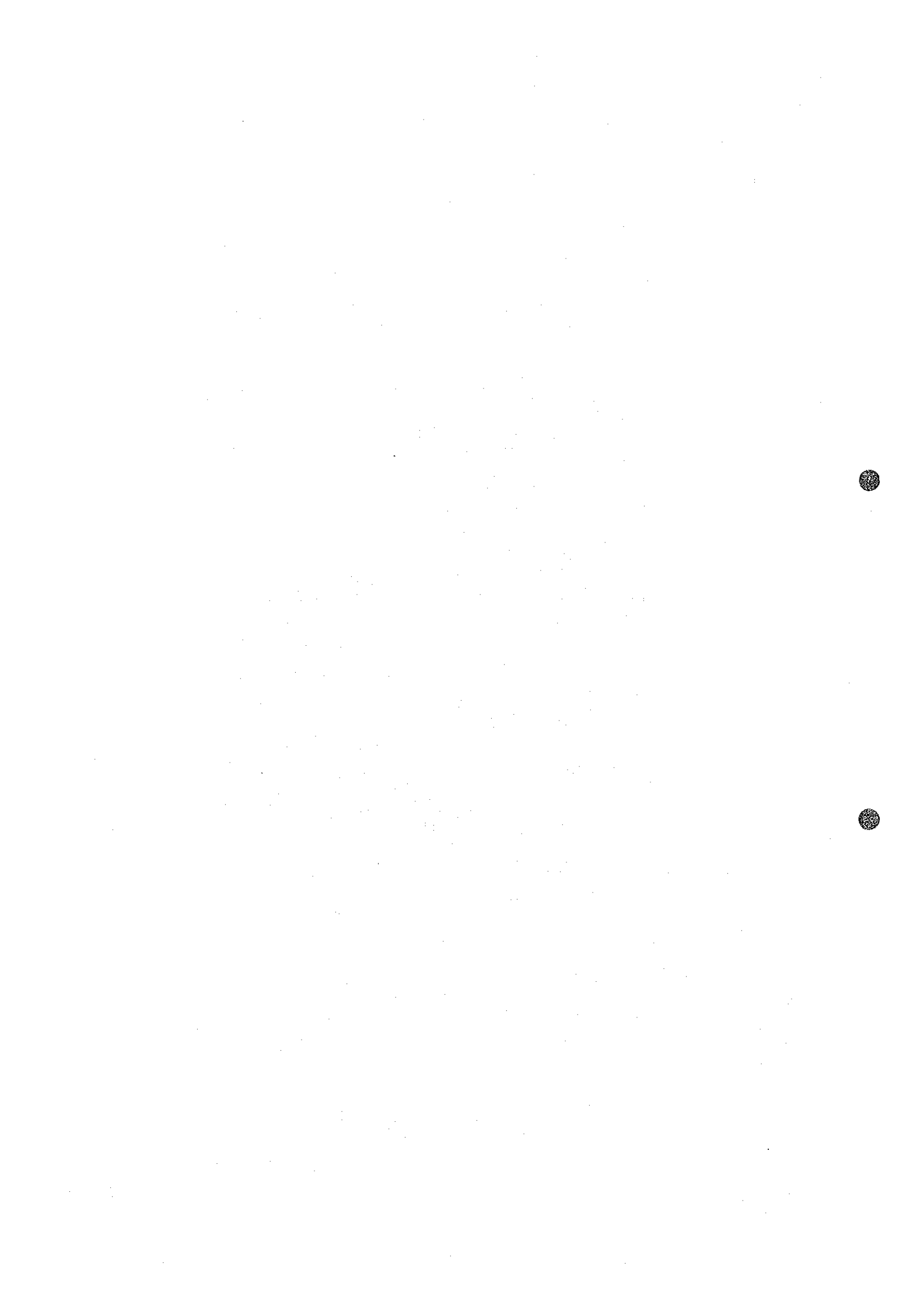
2b S-34 Polished section – Open nicol

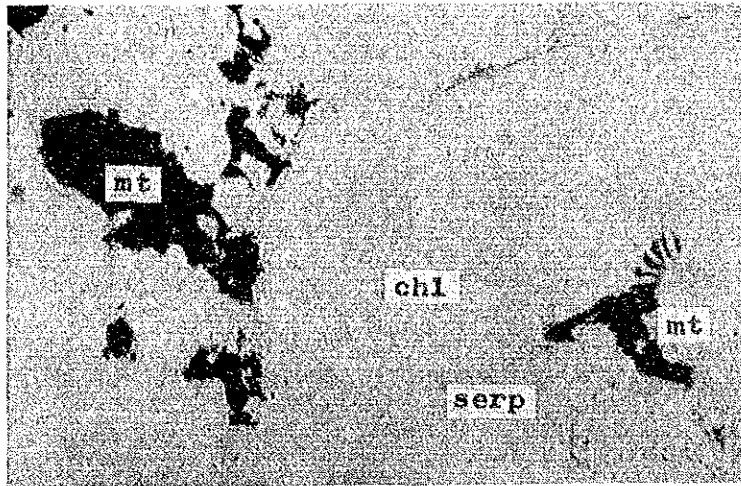
0 0.5mm

Chromite is almost impervious to light.

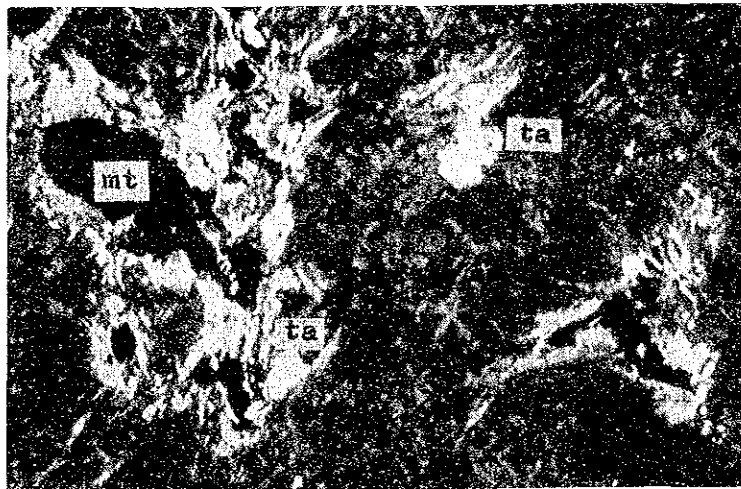
Grain size: 0.06 – 0.6 mm (generally 0.2 – 0.4 mm)

Matrix material: serpentine, chlorite and talc.





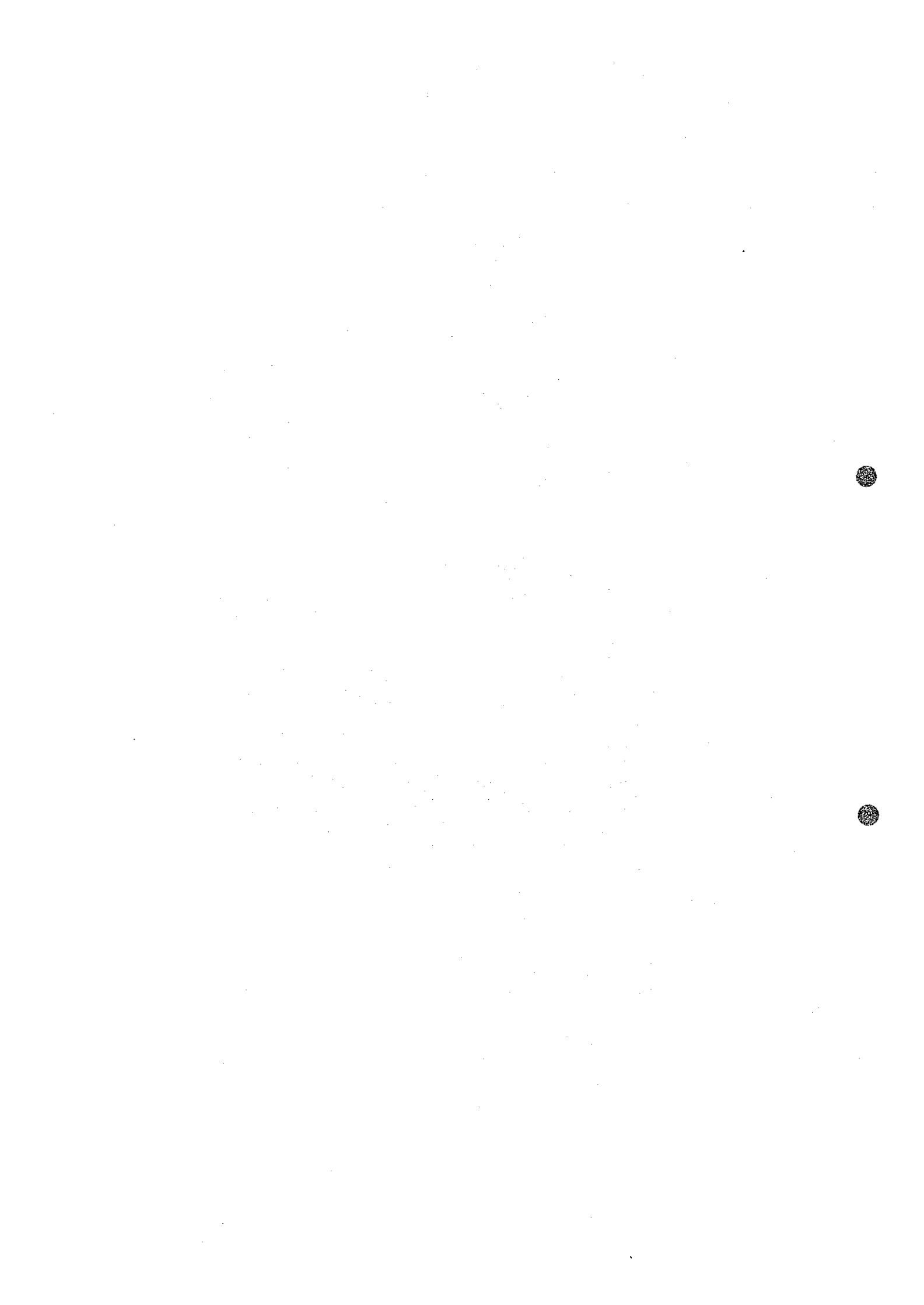
3a S-36 Serpentinite – Opn nicol

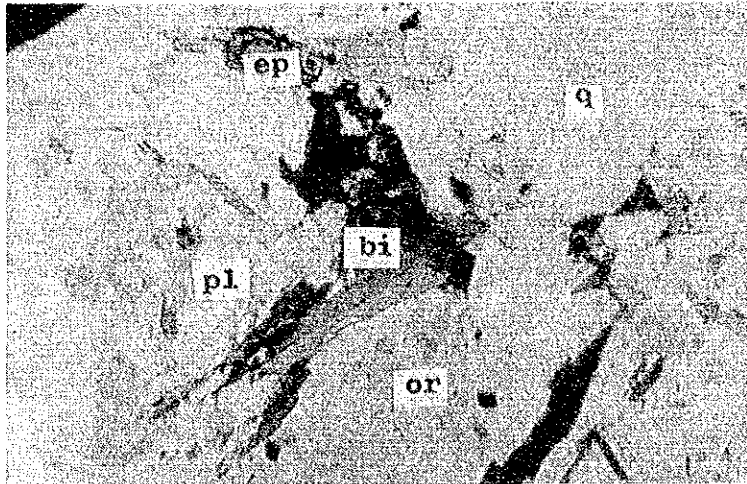


3b Same as the above – Crossed nicols

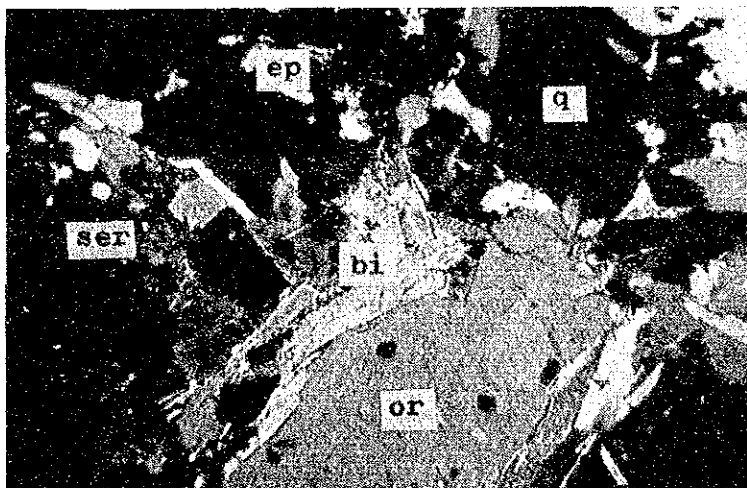
0 _____ 0,5mm

Olivine remains very rarely.
 Most of original minerals have been changed to serpentine, chlorite
 and talc.





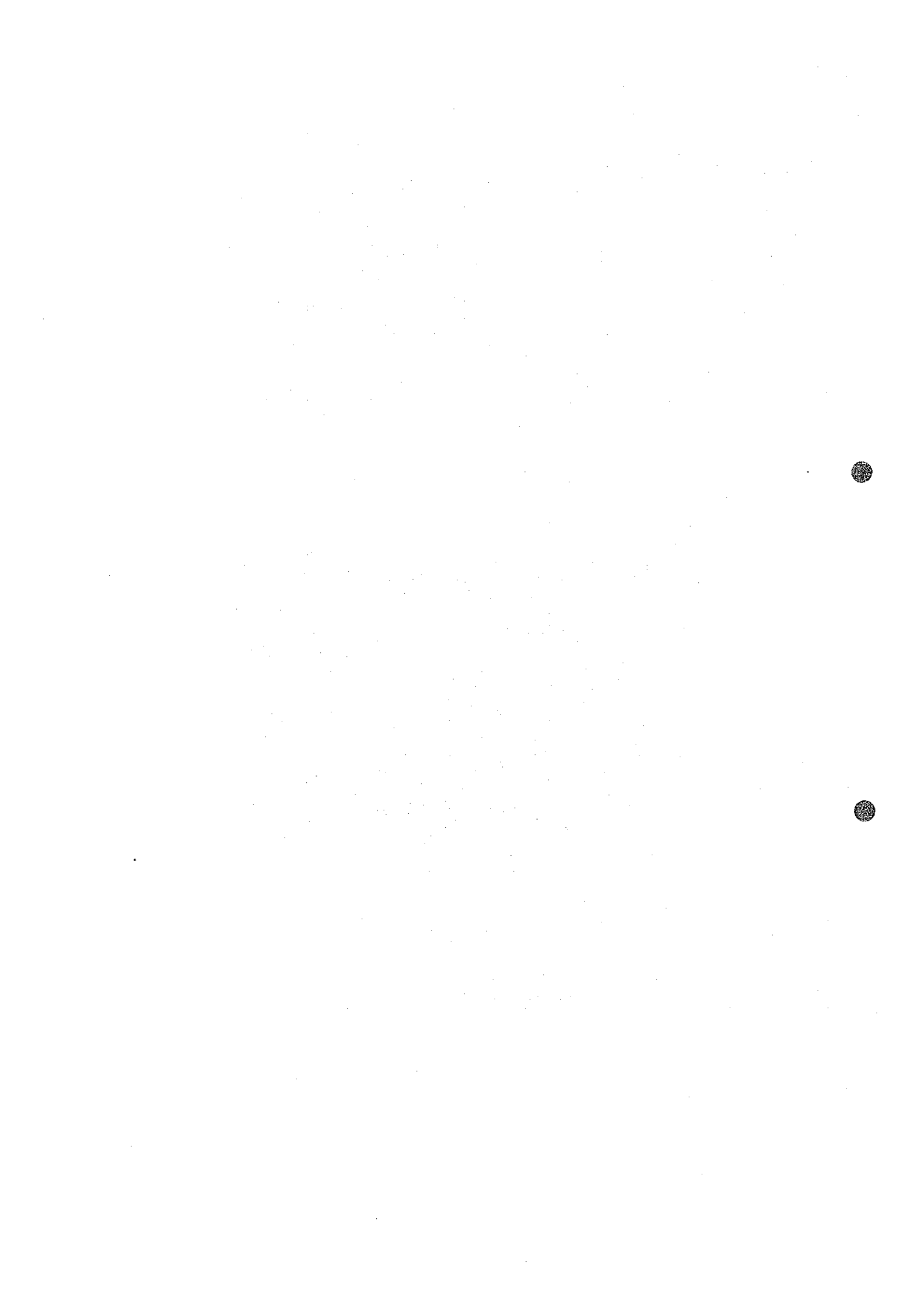
4a S-40 Granite gneiss – Open nicol

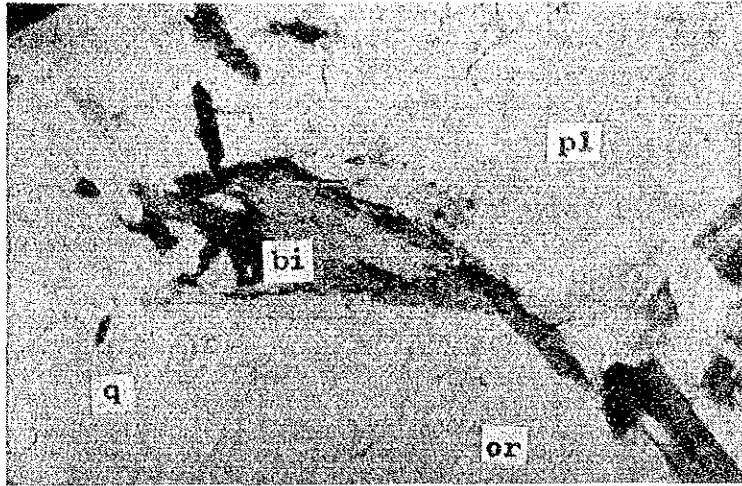


4b Same as the above – Crossed nicols

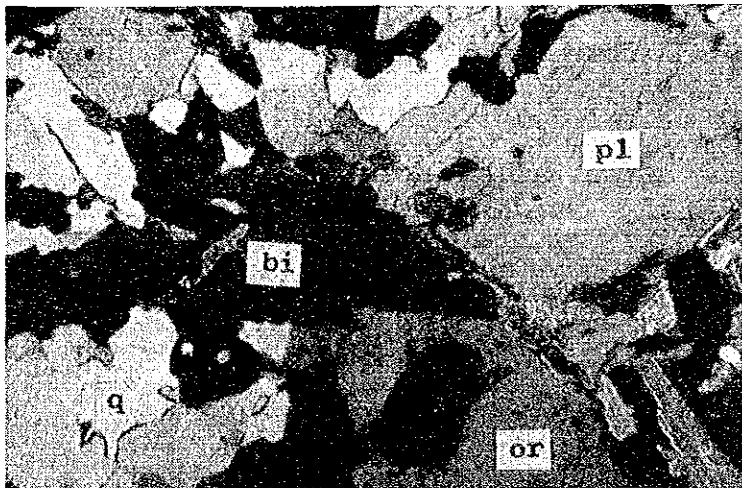
0 ————— 0.5mm

Sample for dating: 1841 ± 92 m.y.
 Weak alteration (sericite, epidote, chlorite)





5a S-48 Granite gneiss — Open nicol

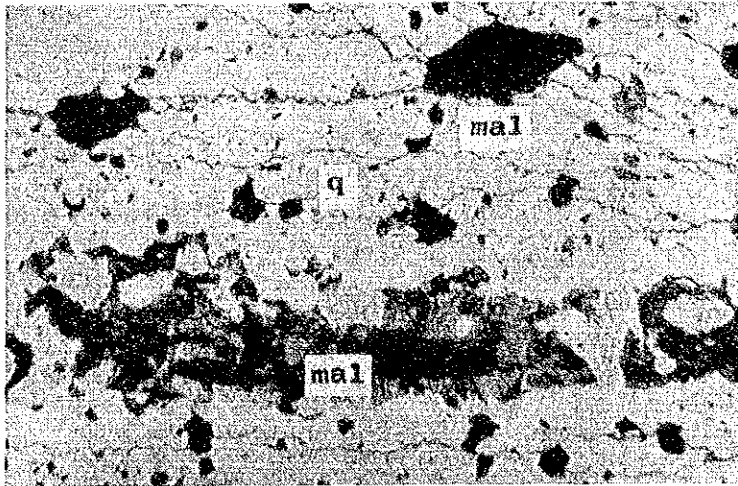


5b Same as the above — Crossed nicols

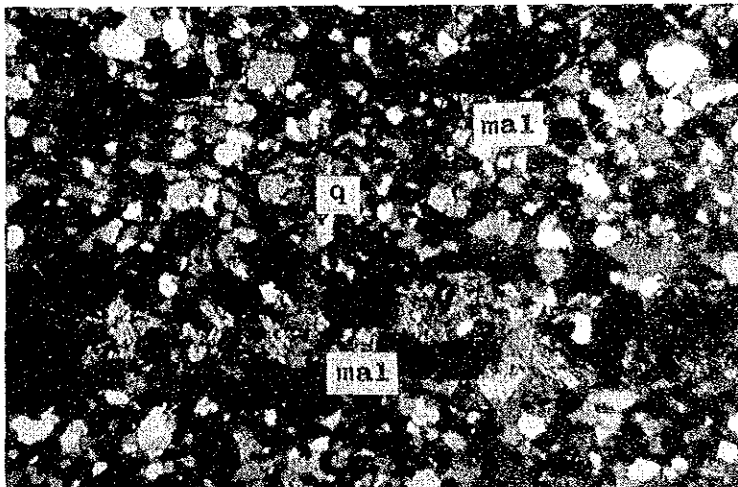
0 ————— 0.5mm

Sample for dating: 1839 ± 92 m.y.
Alteration is weak (sericite, epidote, chlorite).





6a S-68 Quartz schist with malachite - Open nicol

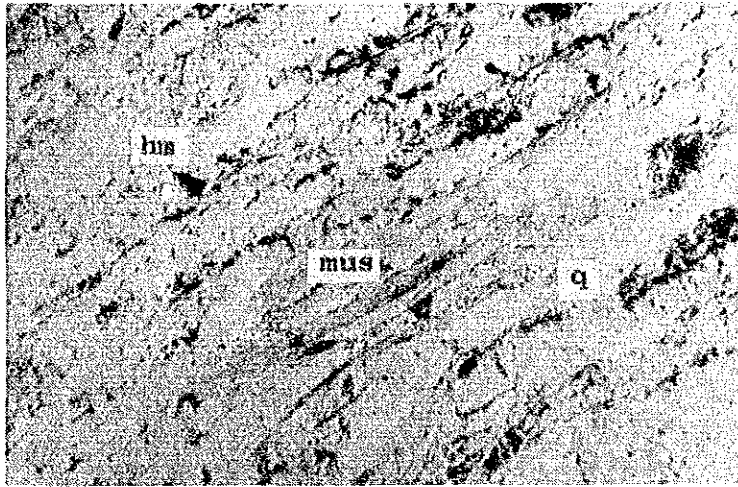


6b Same as the above - Crossed nicols

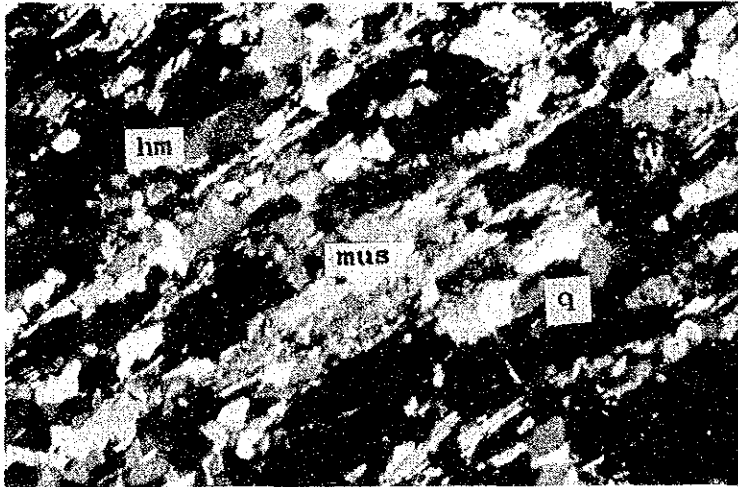
0 0.5mm

Malachite layer is clear.
Metasedimentary copper ore.





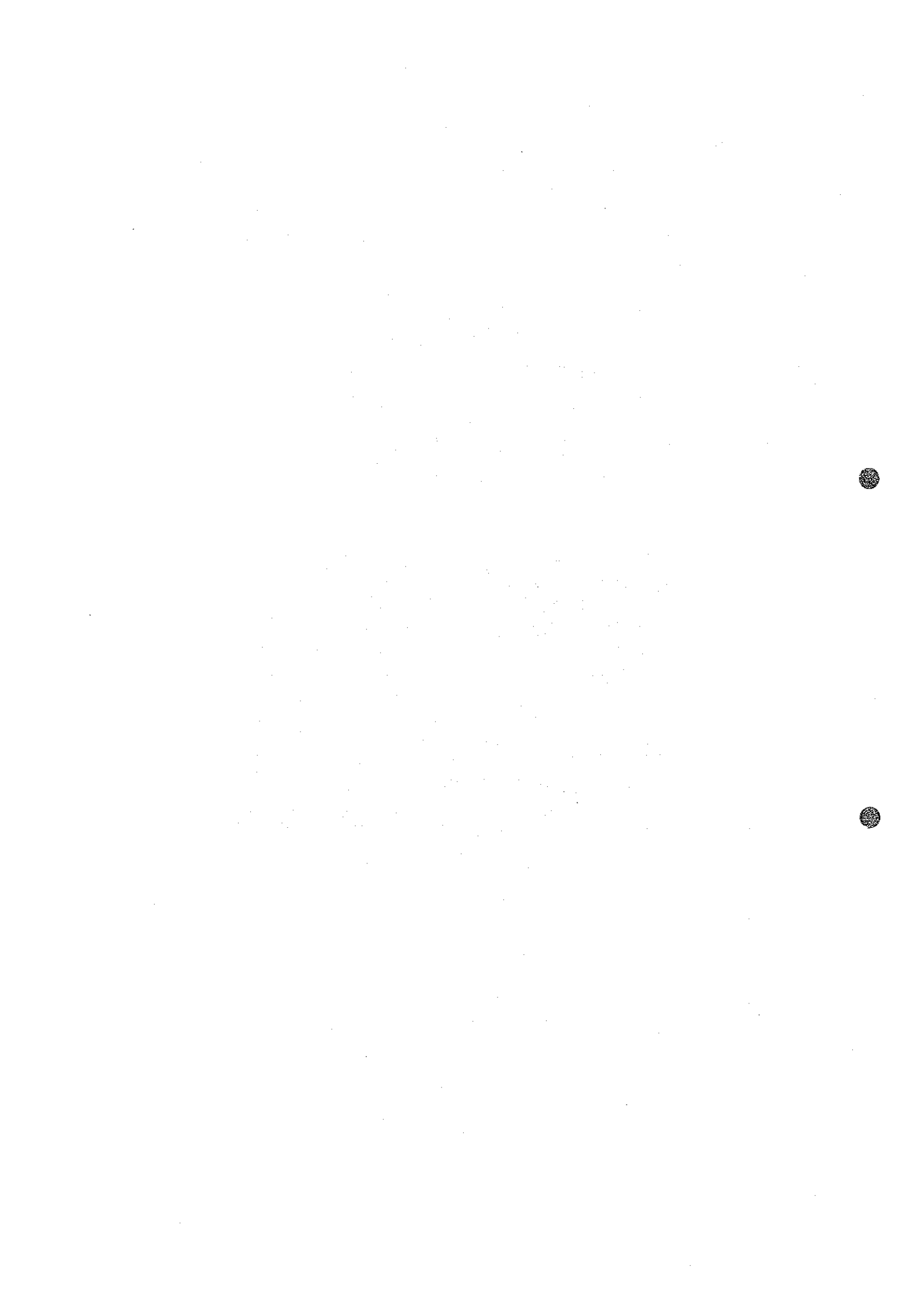
7a S-72 Muscovite quartz schist – Open nicol

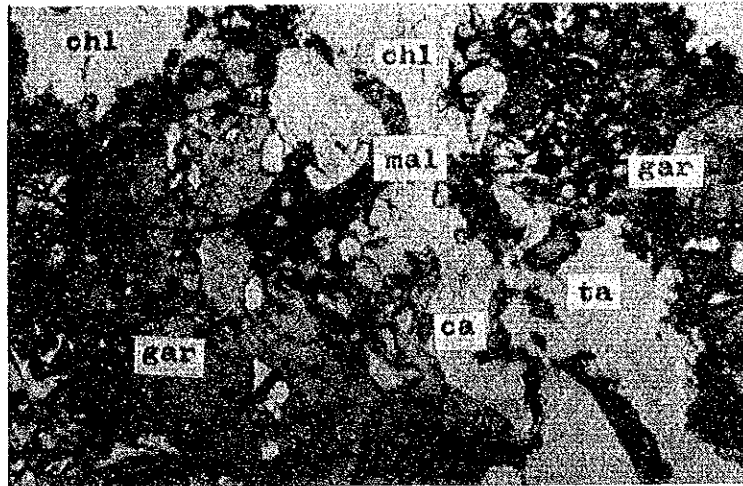


7b Same as the above – Crossed nicols

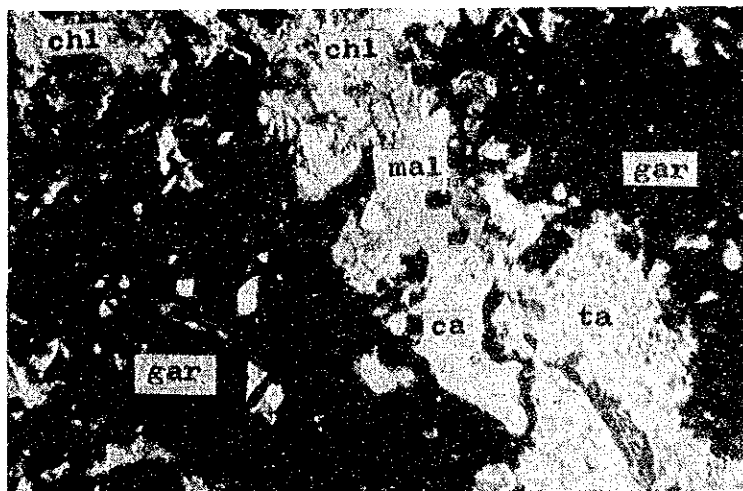
0 0.5mm

A horizontal scale bar with a vertical tick at the left end labeled '0' and a vertical tick at the right end labeled '0.5mm'. The bar is divided into five equal segments by four vertical tick marks.





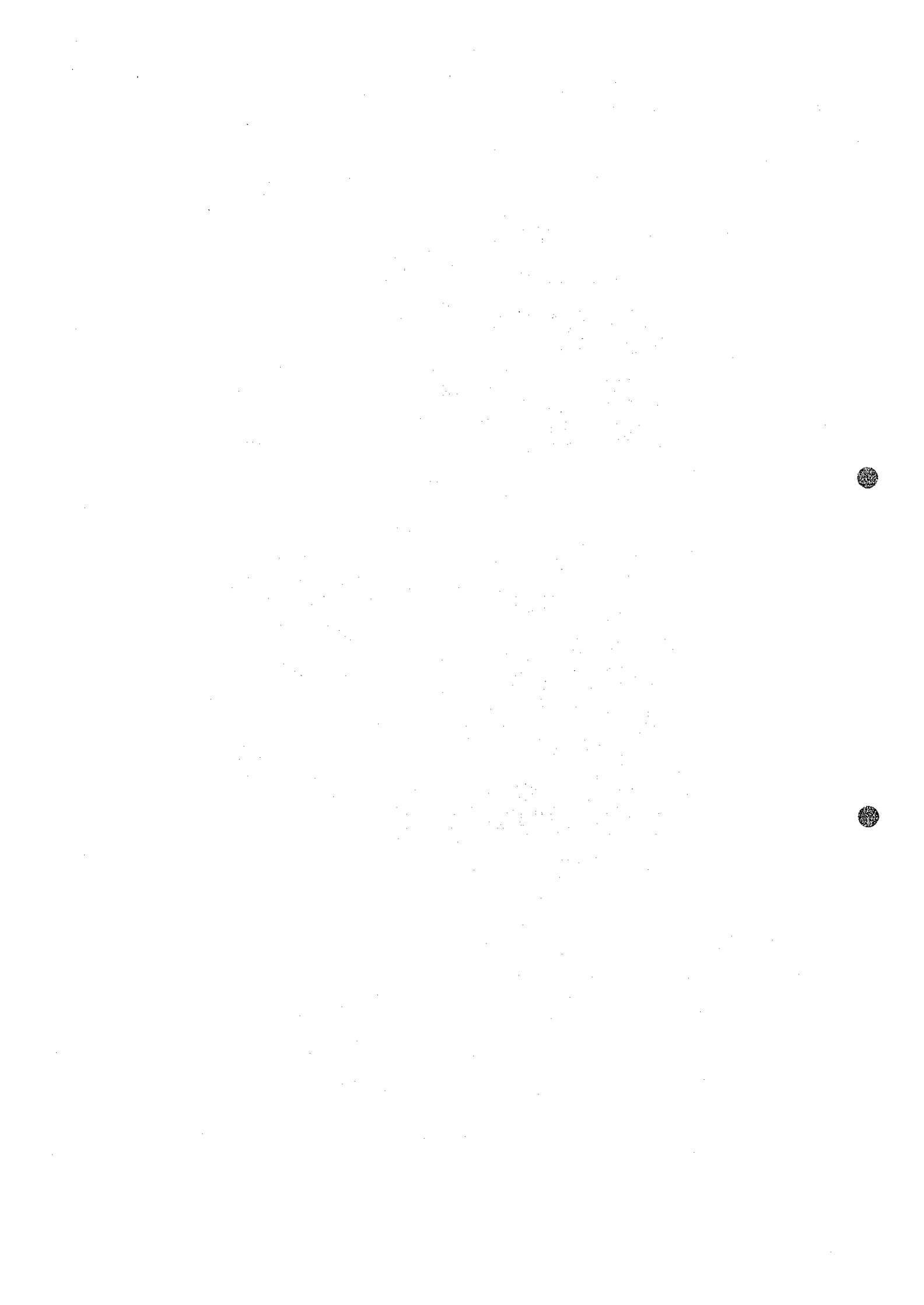
8a S-81 Garnet bearing rock - Open nicol

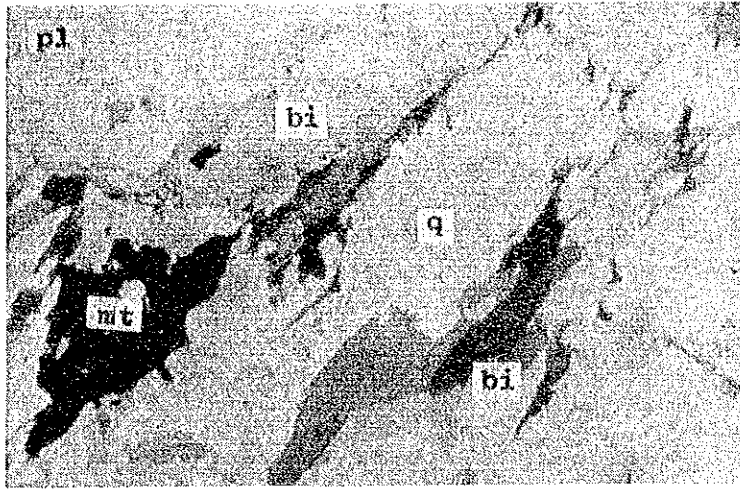


8b Same as the above - Crossed nicols

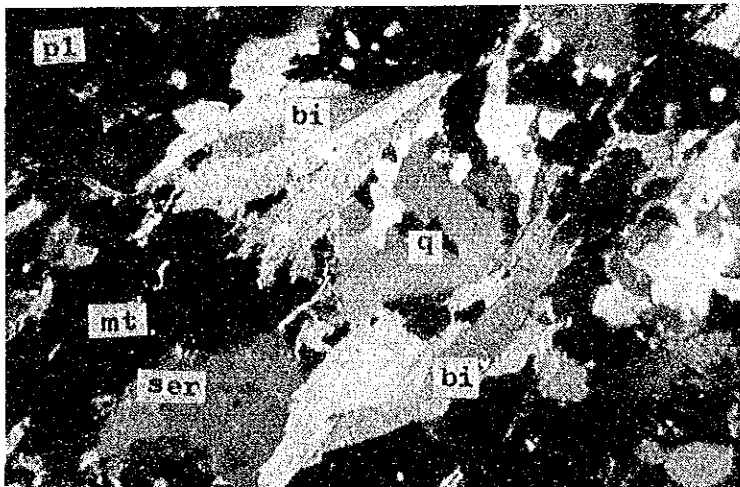
0 0.5mm

The sample is dark green hard rock with much garnet. Malachite is contained in this sample.





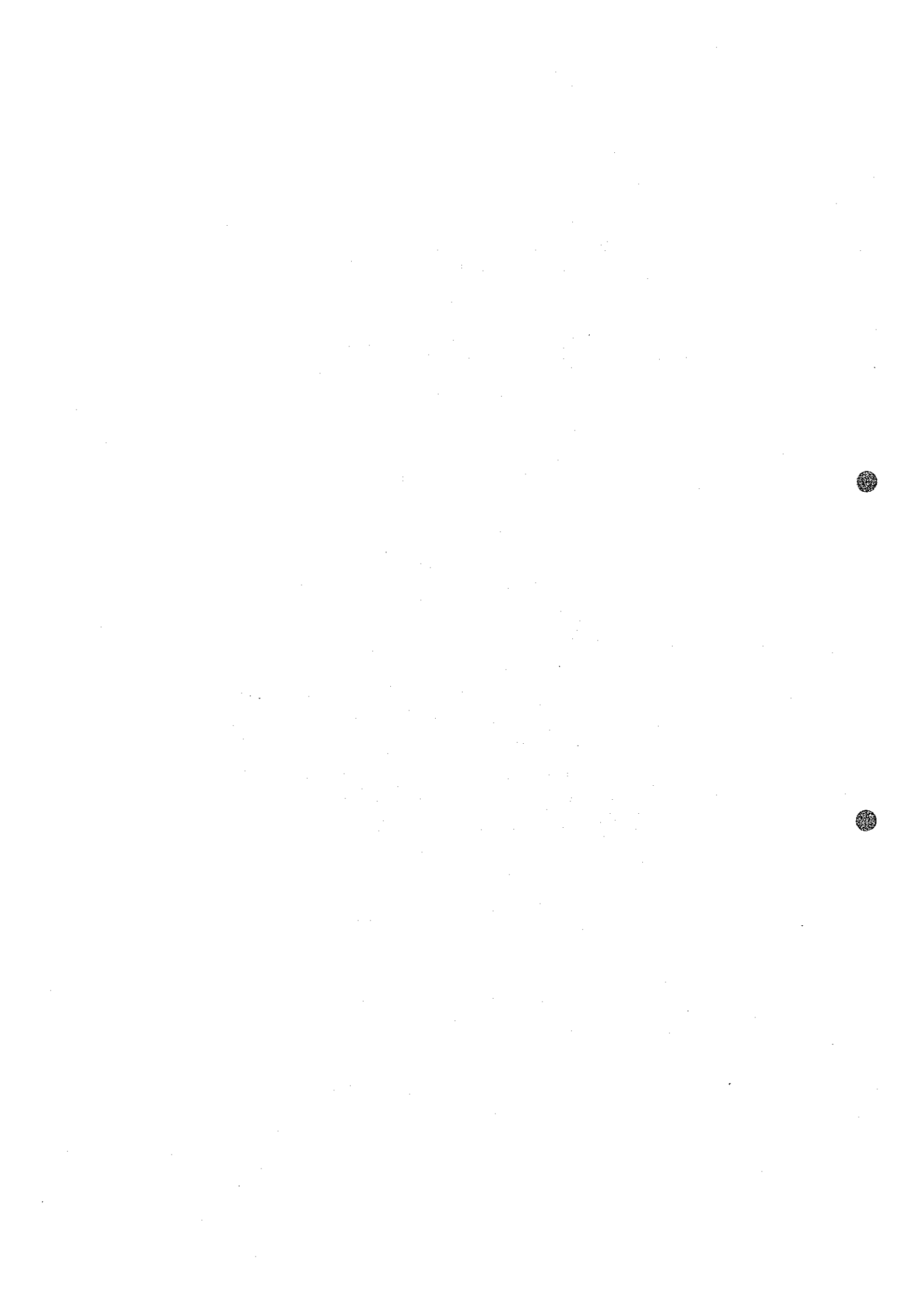
9a S-104 Granite gneiss - Open nicol

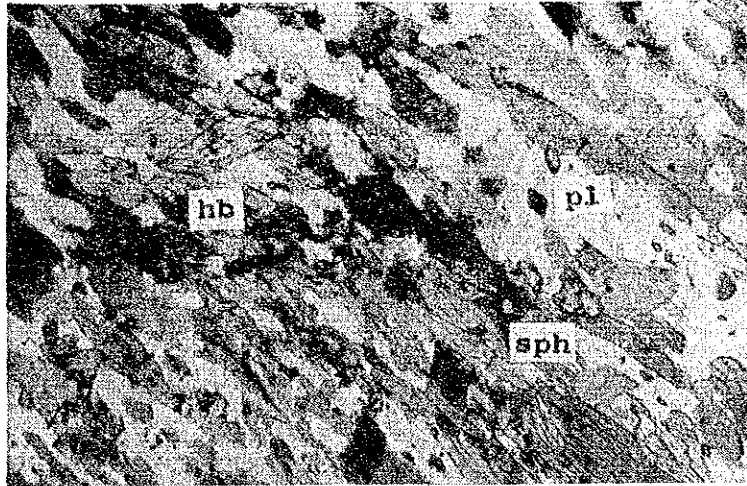


9b Same as the above - Crossed nicols

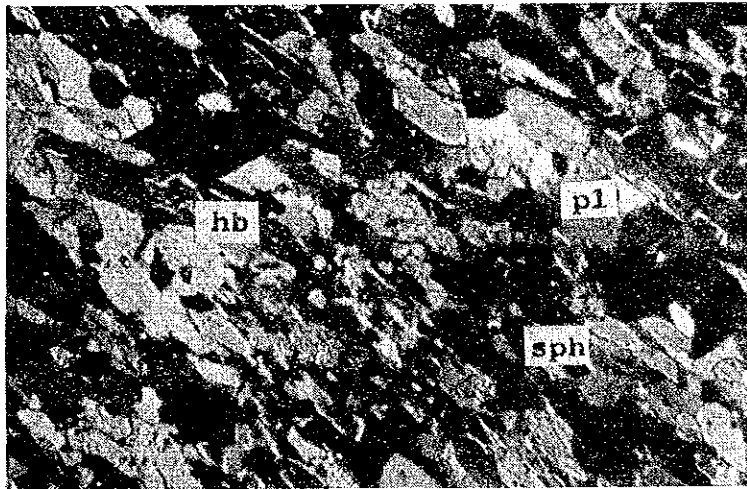
0 _____ 0.5mm

Sample for dating: 1837 ± 92 m.y.
Weak alteration (sericite, chlorite).





10a S-112 Amphibole schist – Open nicol



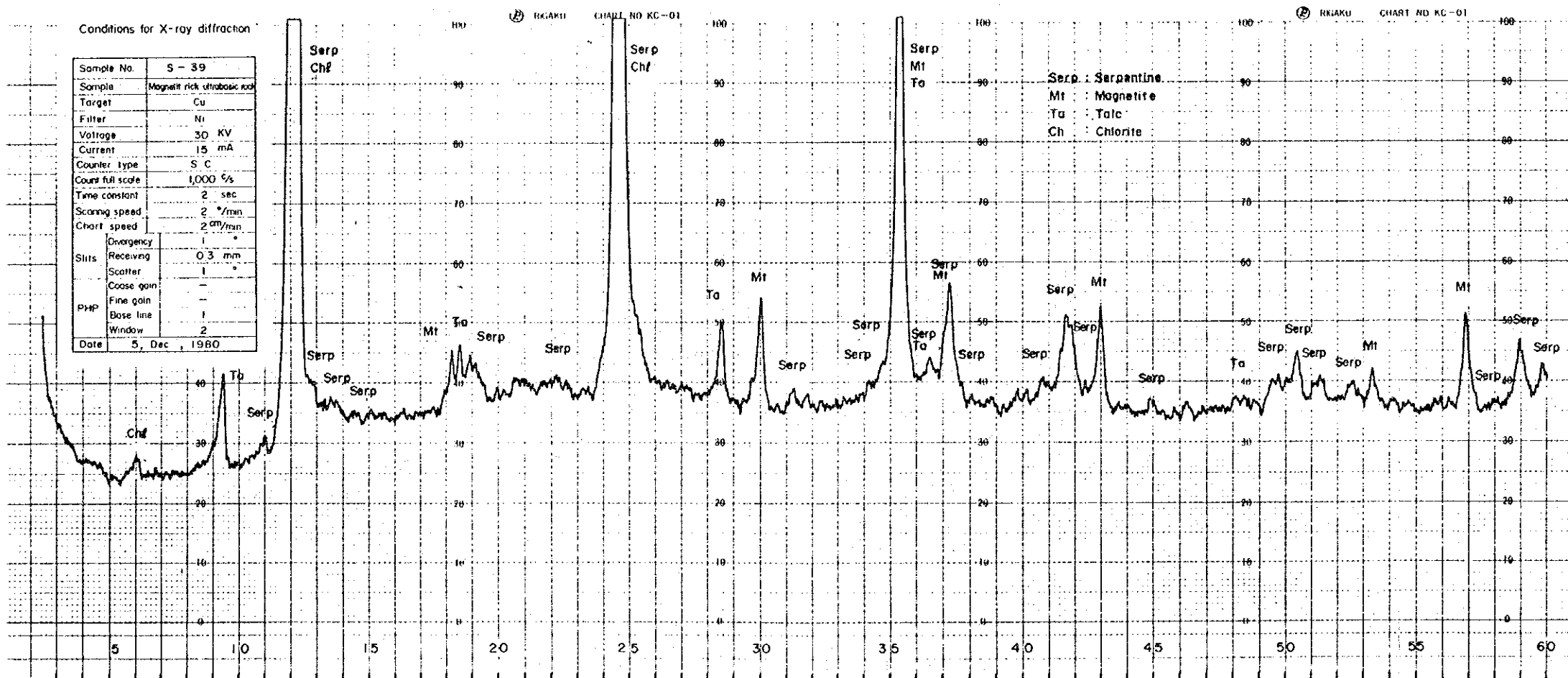
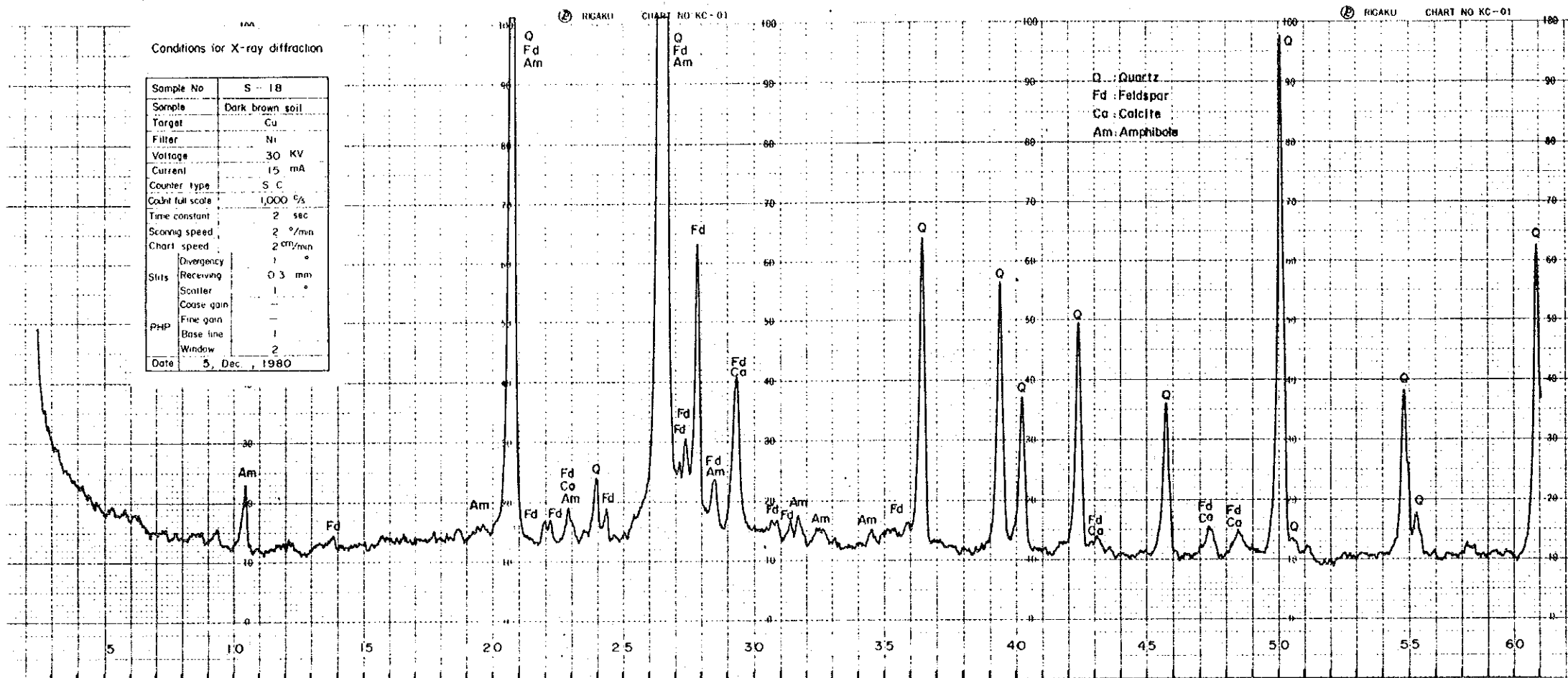
10b Same as the above – Crossed nicols

0 0.5mm

Sample for dating: 1755 ± 88 m.y.
Alteration is very weak.

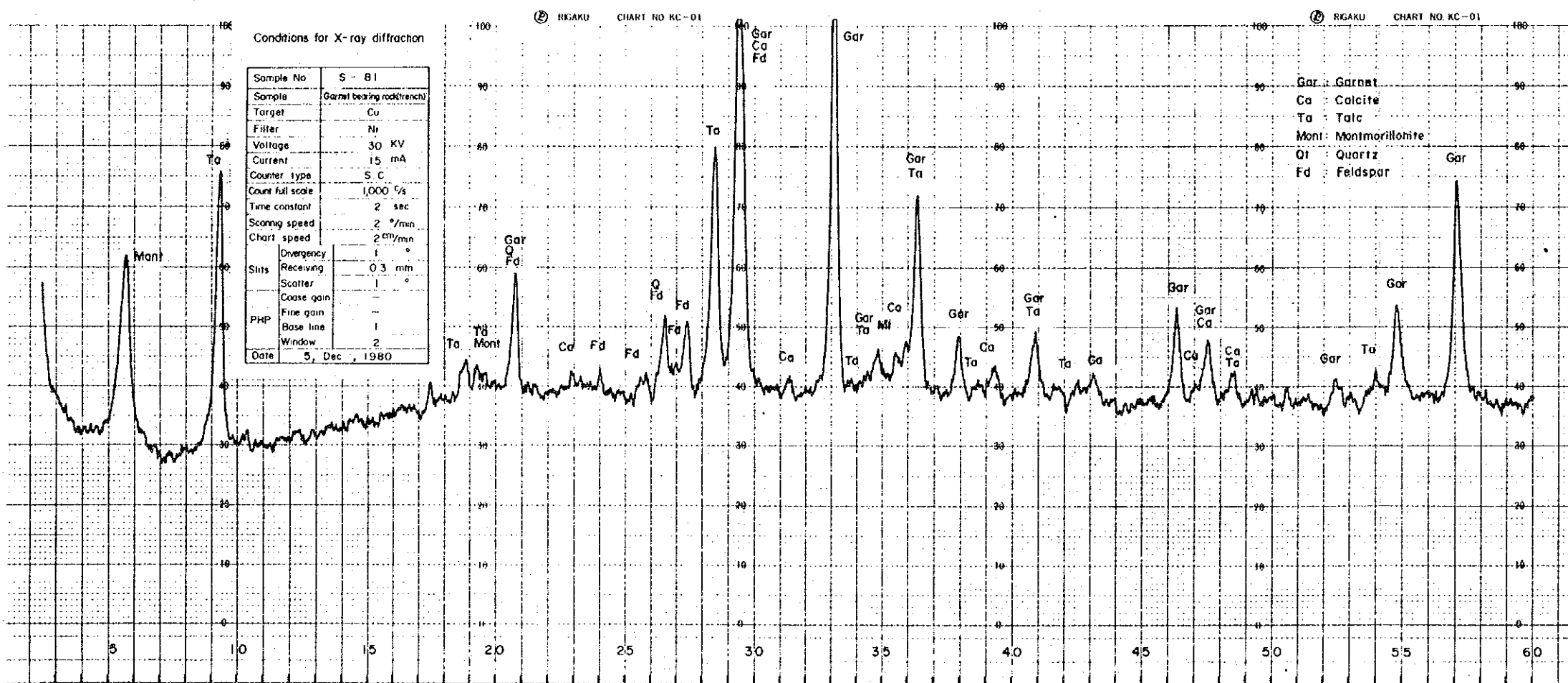
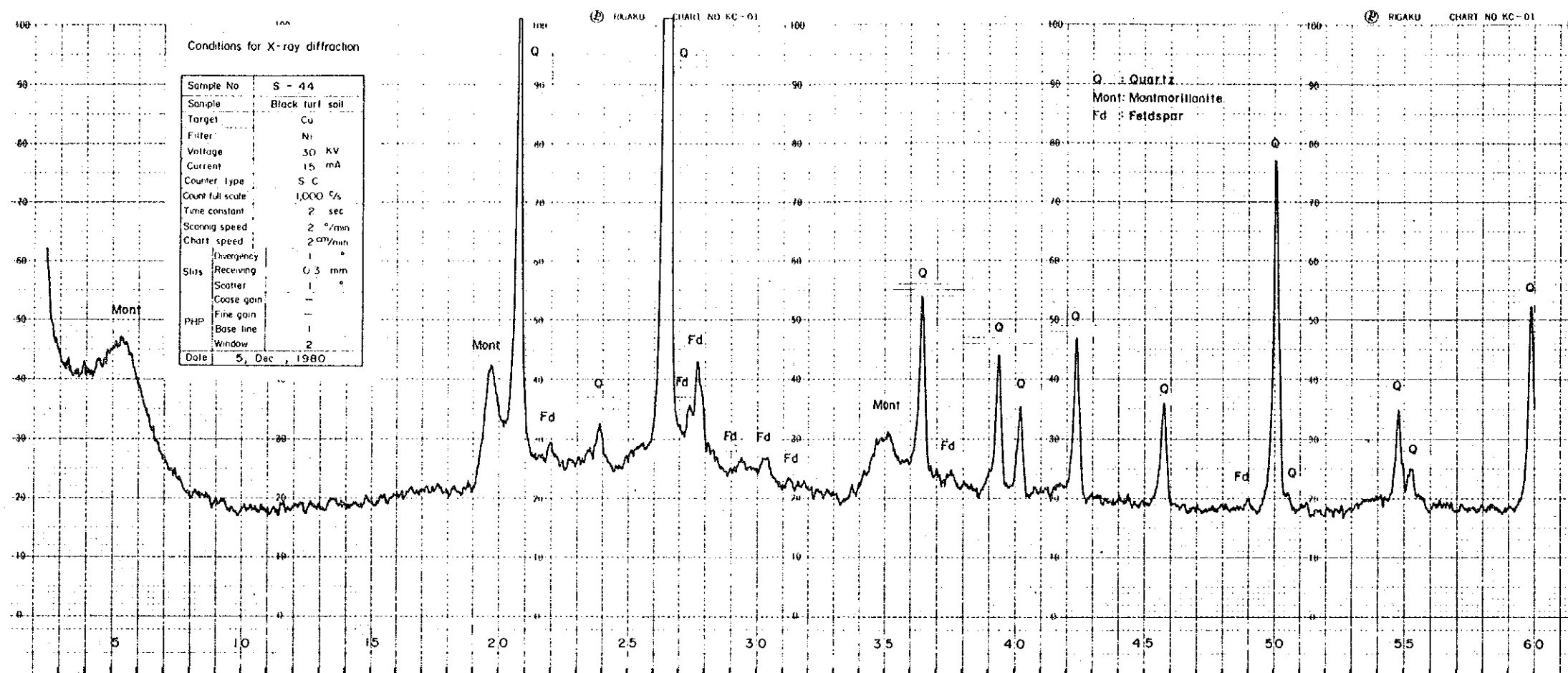
Charts of X-ray diffraction
and fluorescence

Sample S-18
S-39



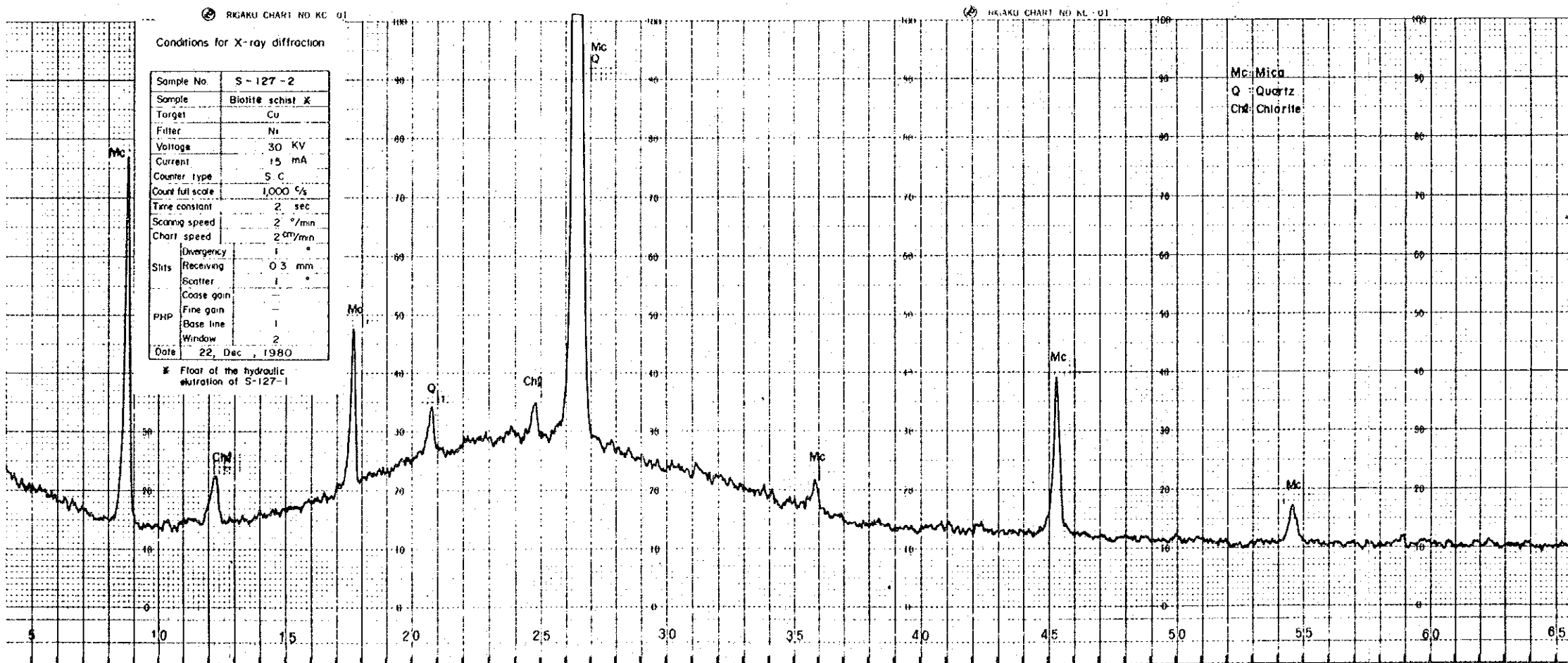
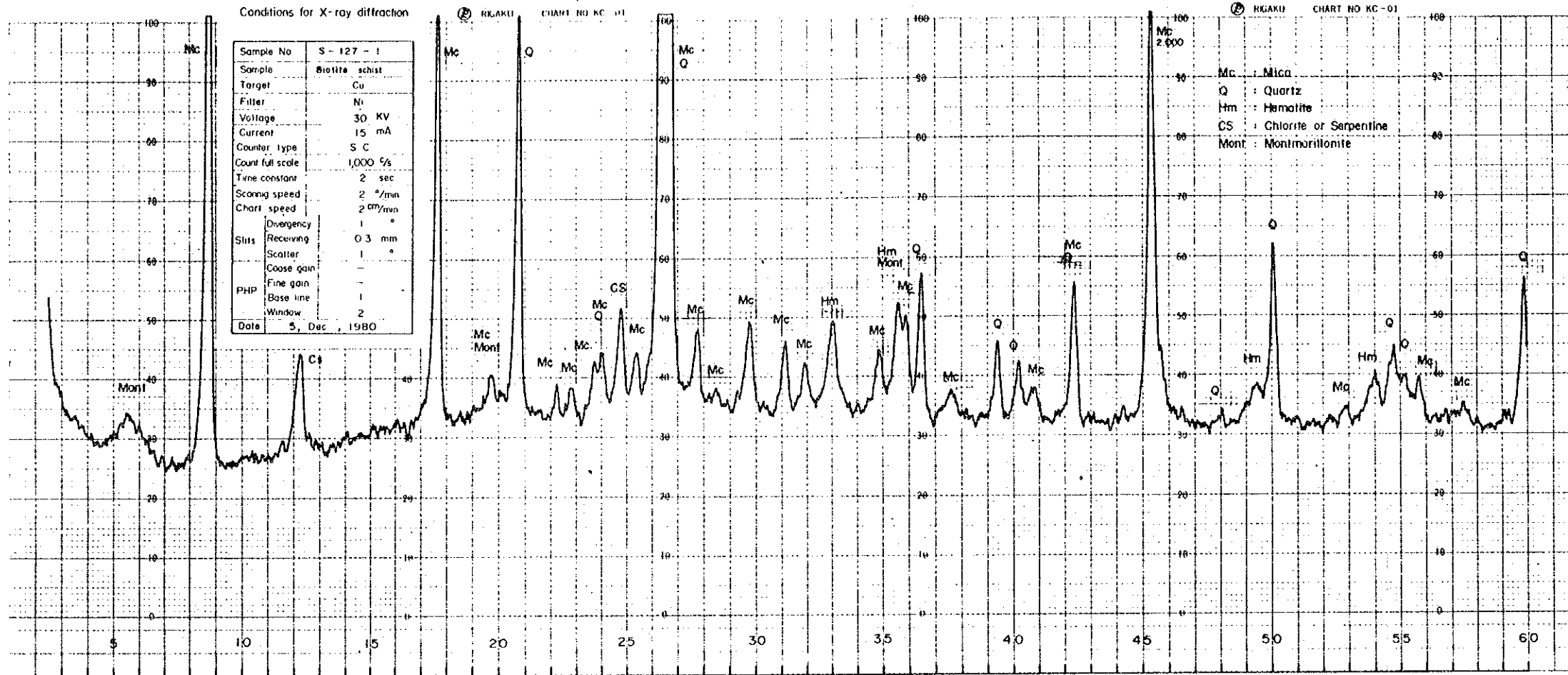
Charts of X-ray diffraction and fluorescence

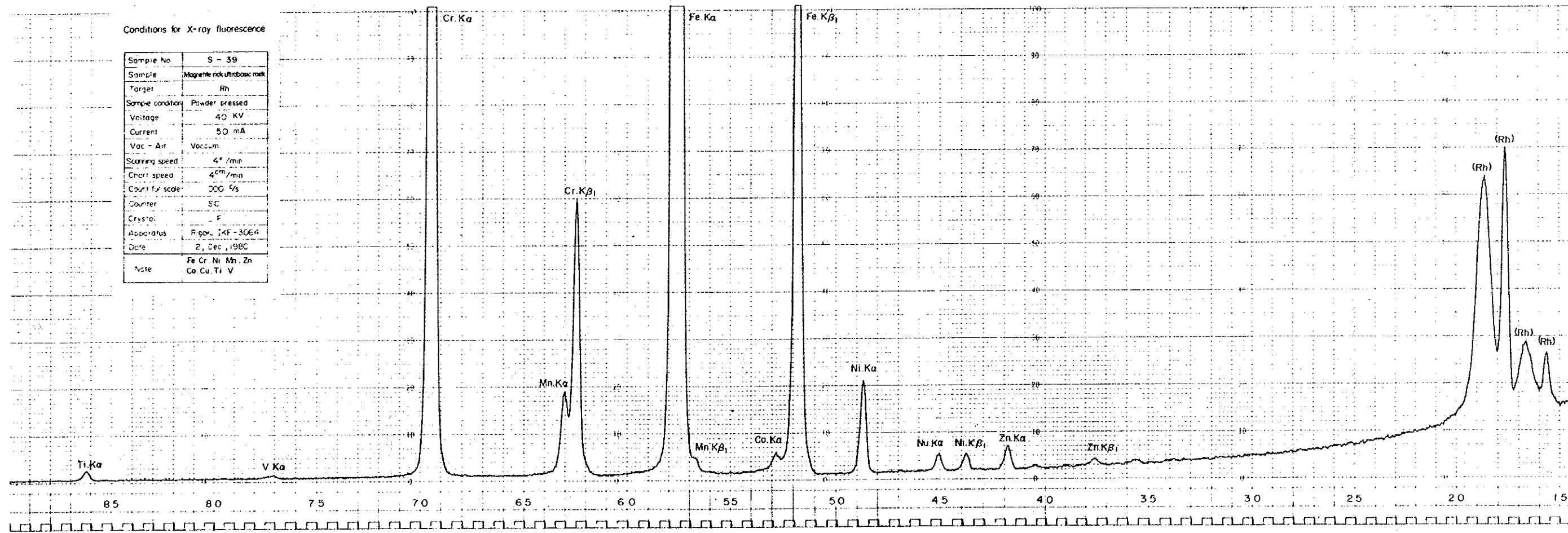
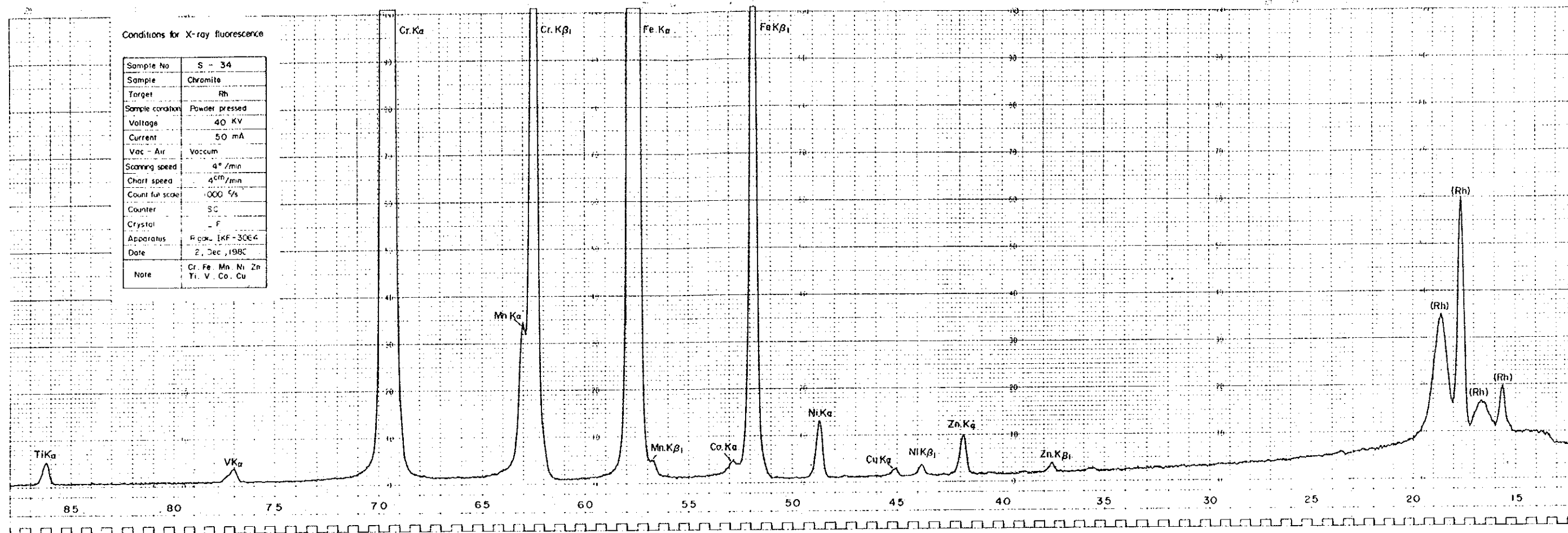
Sample S-44
S-81



Charts of X-ray diffraction and fluorescence

Sample S-127-1
S-127-2

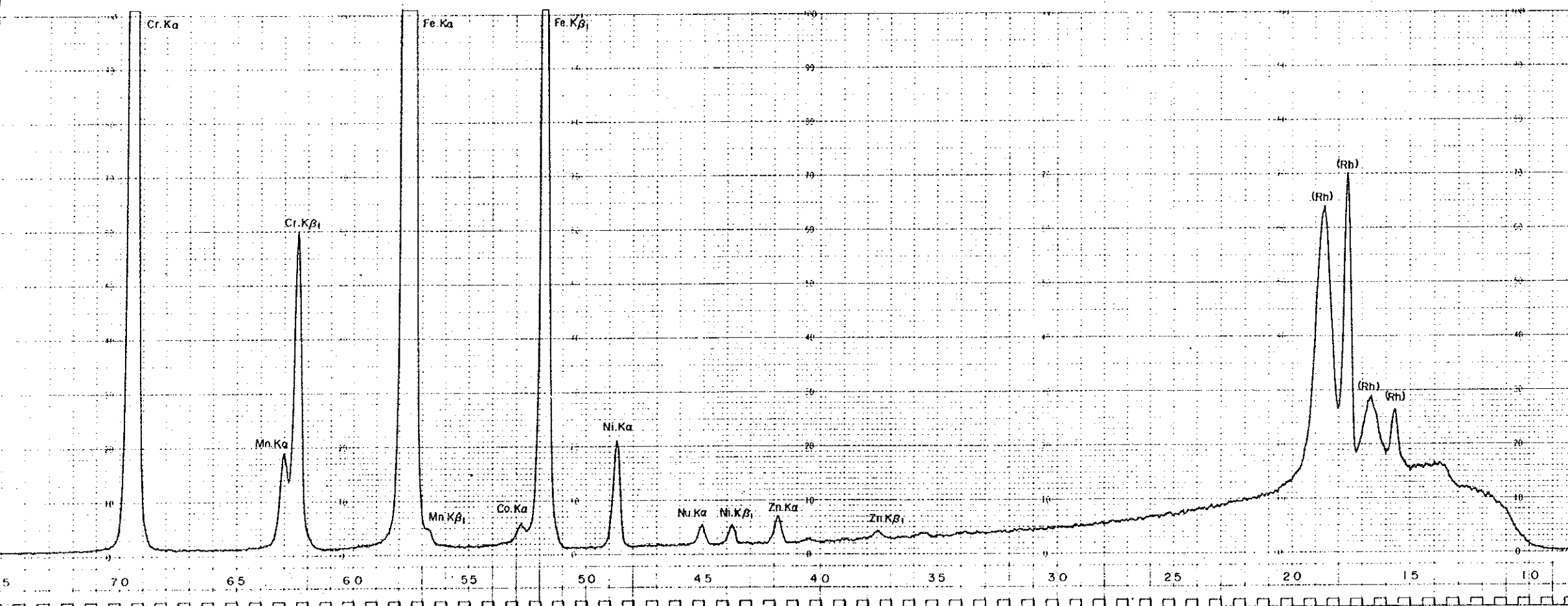
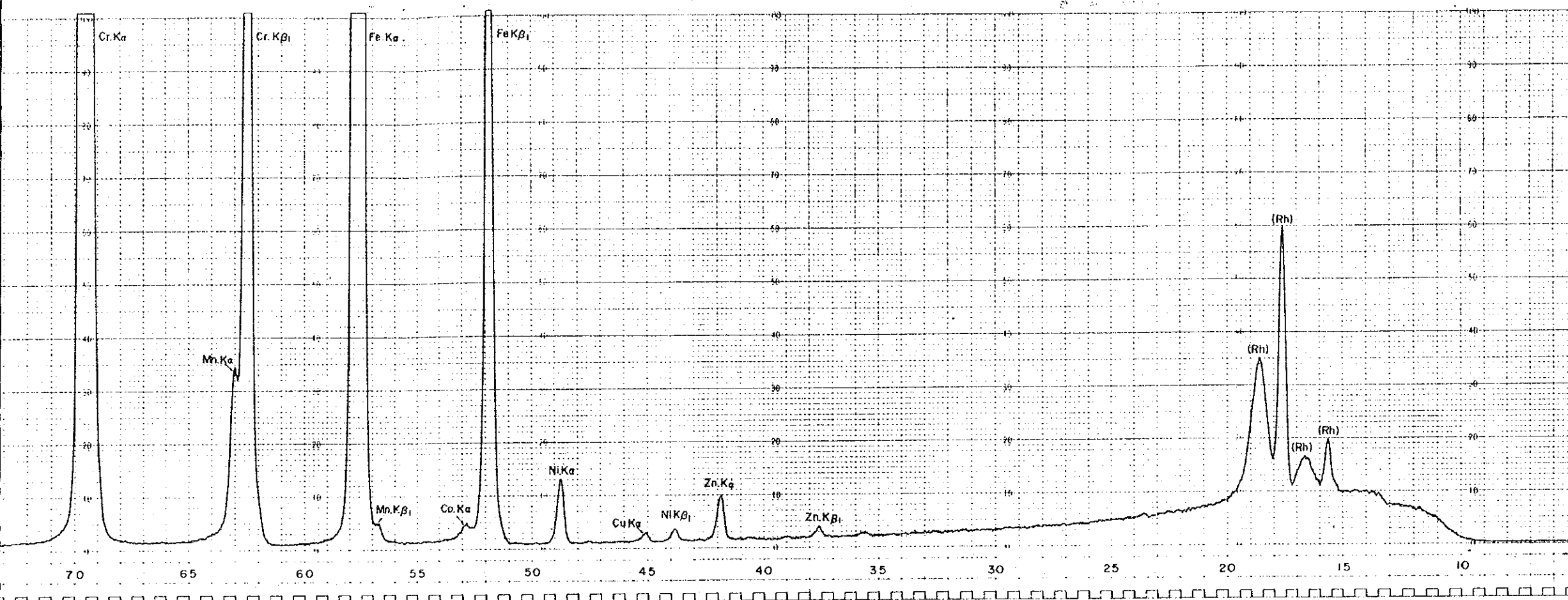


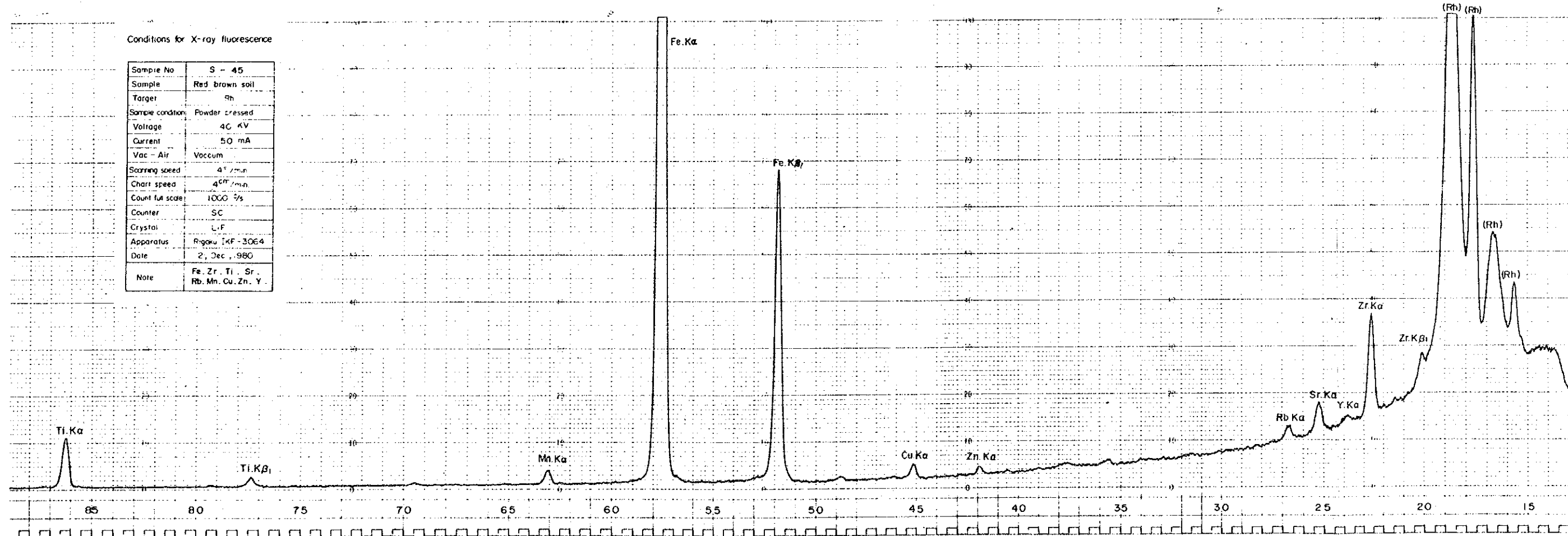
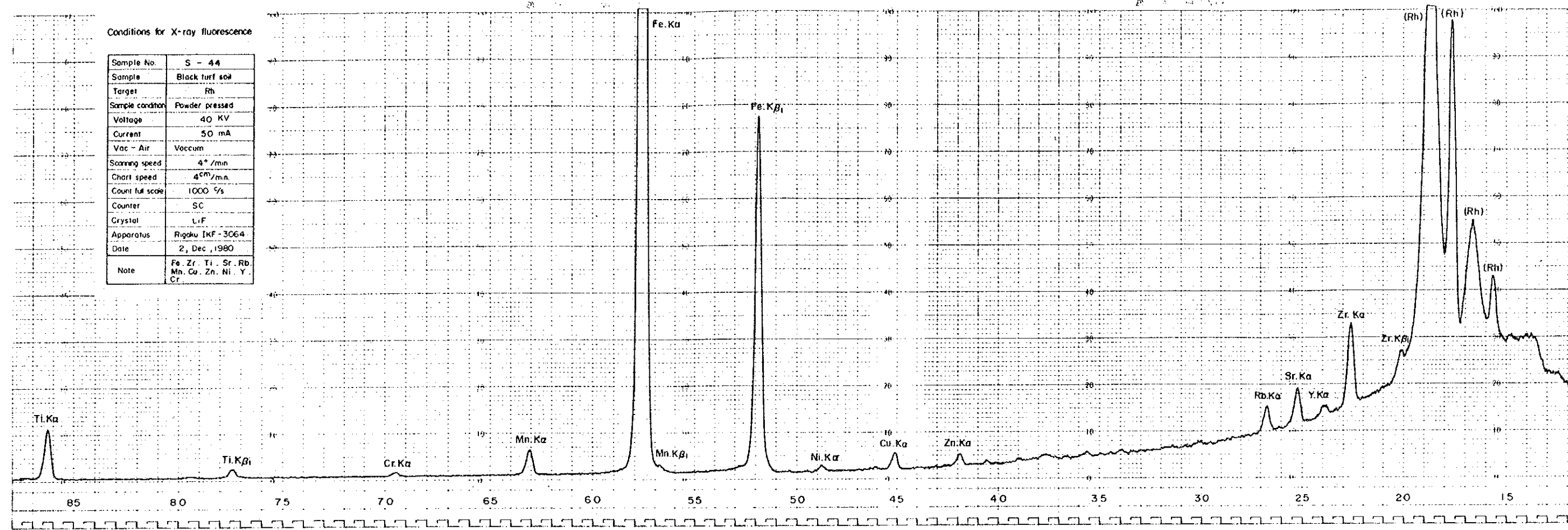


Apex. 3-4

Charts of X-ray diffraction
and fluorescence

Sample S-34
S-39

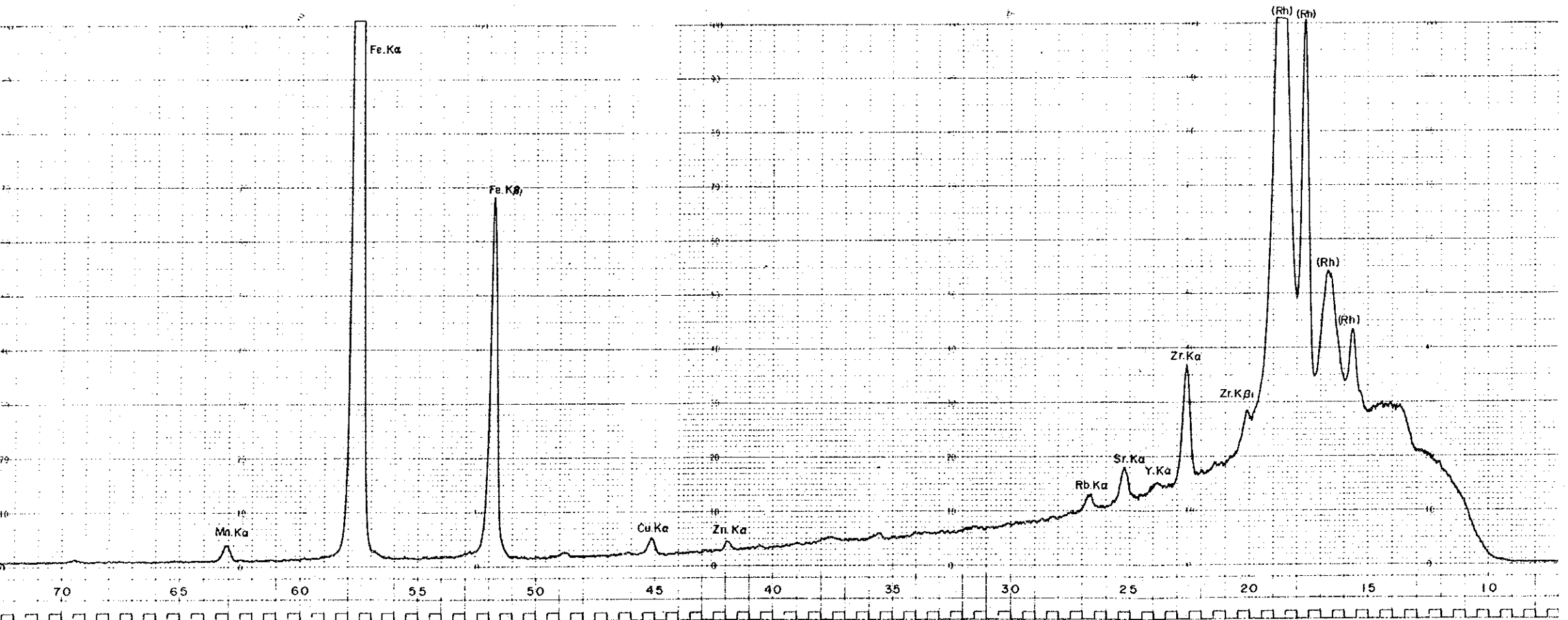
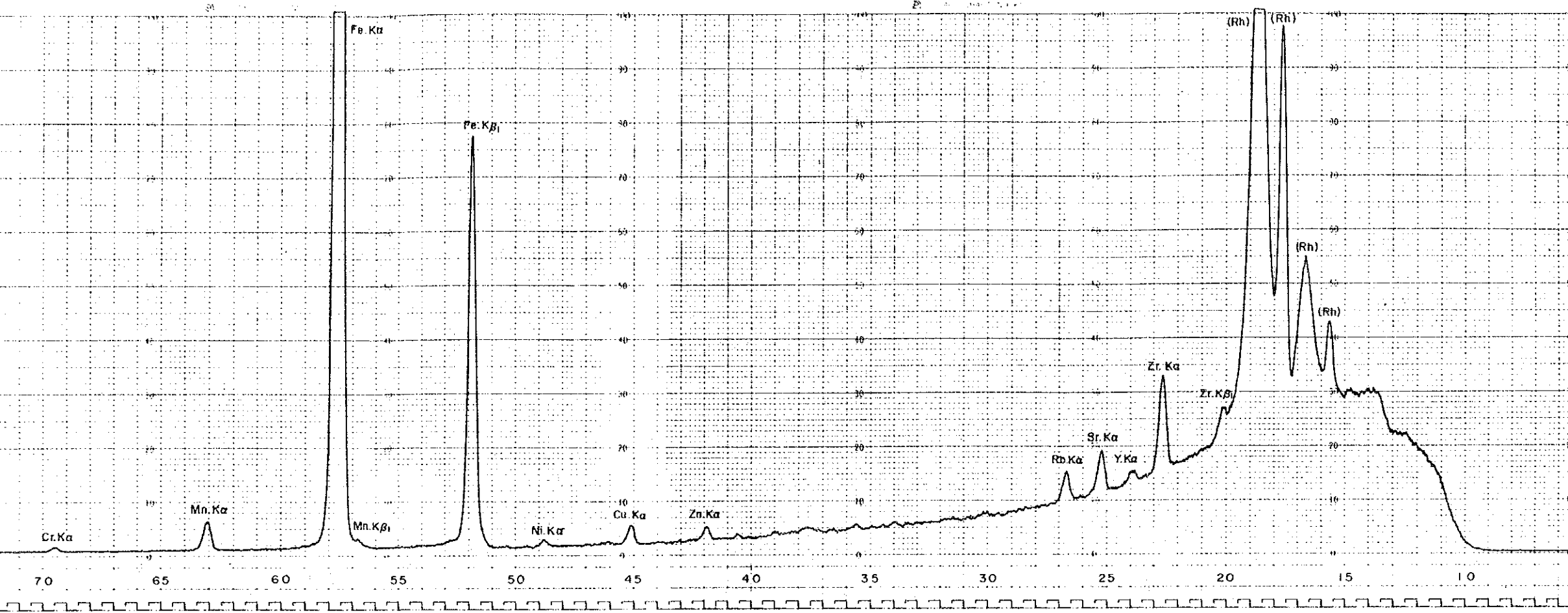




Apex. 3-5

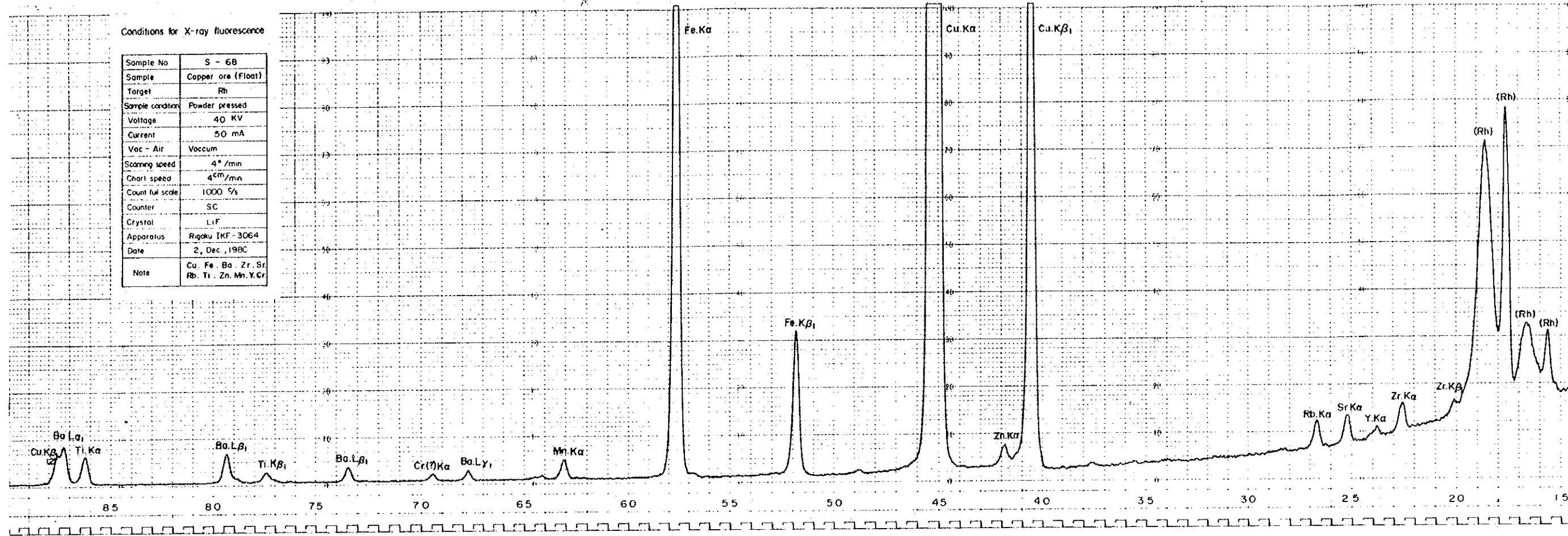
Charts of X-ray diffraction
and fluorescence

Sample S-44
S-45



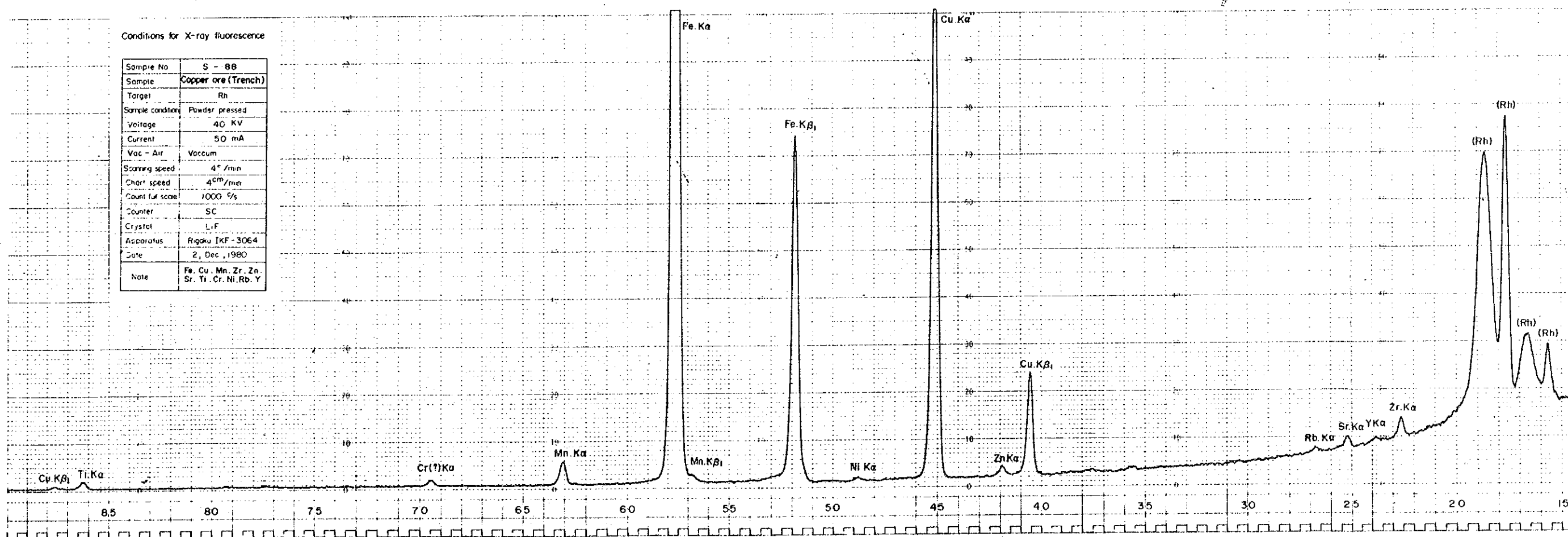
Conditions for X-ray fluorescence

Sample No	S - 68
Sample	Copper ore (Float)
Target	Rh
Sample condition	Powder pressed
Voltage	40 KV
Current	50 mA
Vac - Air	Vacuum
Scanning speed	4°/min
Chart speed	4cm/min
Count full scale	1000 %s
Counter	SC
Crystal	LIF
Apparatus	Rigaku IKF-3064
Date	2, Dec, 1980
Note	Cu, Fe, Ba, Zr, Sr, Rb, Ti, Zn, Mn, Y, Cr



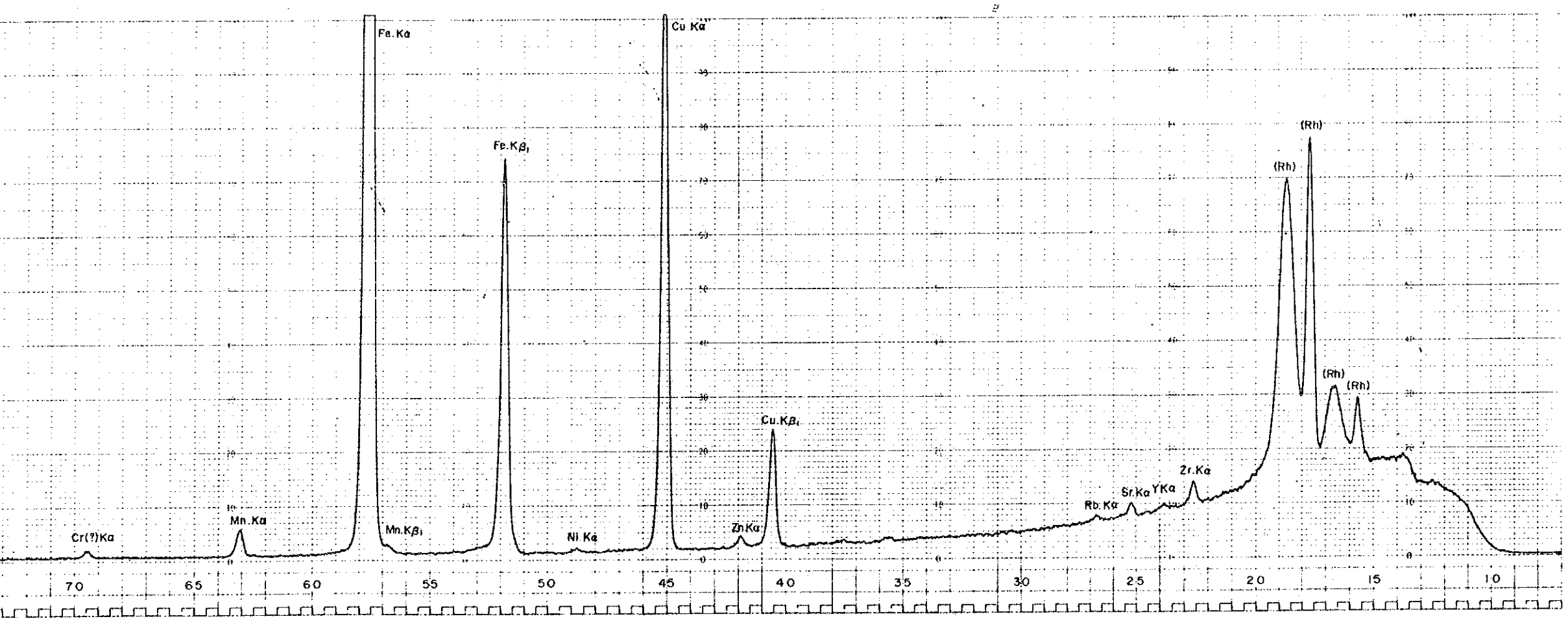
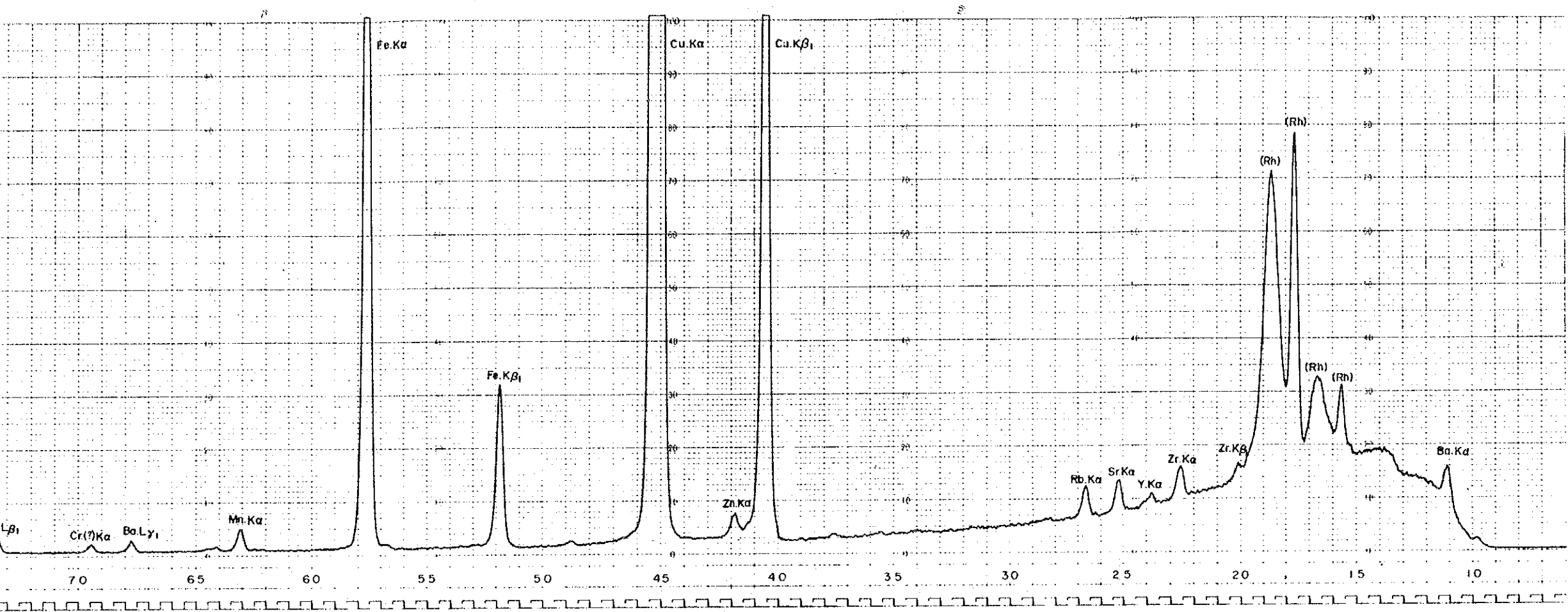
Conditions for X-ray fluorescence

Sample No	S - 88
Sample	Copper ore (Trench)
Target	Rh
Sample condition	Powder pressed
Voltage	40 KV
Current	50 mA
Vac - Air	Vacuum
Scanning speed	4°/min
Chart speed	4cm/min
Count full scale	1000 %s
Counter	SC
Crystal	LIF
Apparatus	Rigaku IKF-3064
Date	2, Dec, 1980
Note	Fe, Cu, Mn, Zr, Zn, Sr, Ti, Cr, Ni, Rb, Y



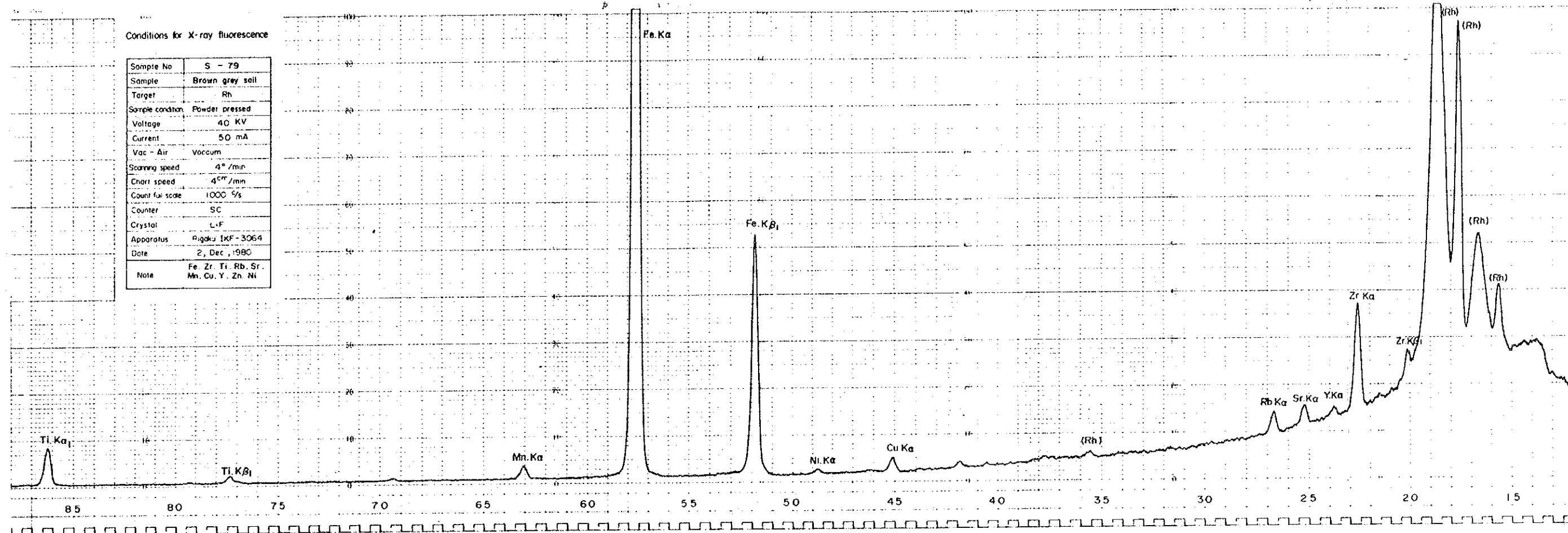
Charts of X-ray diffraction and fluorescence

Sample S-68
S-88



Conditions for X-ray fluorescence

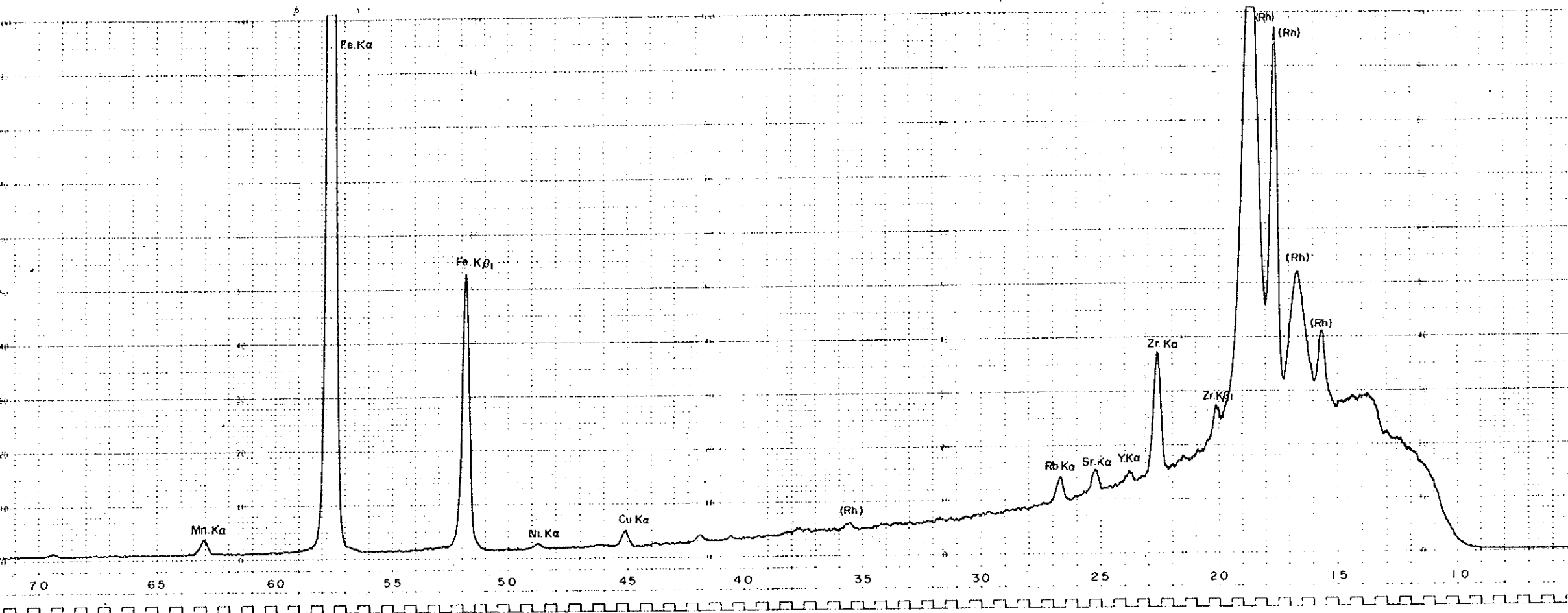
Sample No	S - 79
Sample	Brown grey soil
Target	Rh
Sample condition	Powder pressed
Voltage	40 KV
Current	50 mA
Vac - Air	Vacuum
Scanning speed	4° /min
Chart speed	45" /min
Count rate scale	10000 %
Counter	SC
Crystal	LiF
Apparatus	Rigaku [KF-3064]
Date	2, Dec., 1980
Note	Fe, Zr, Ti, Rb, Sr, Mn, Cu, Y, Zn, Ni



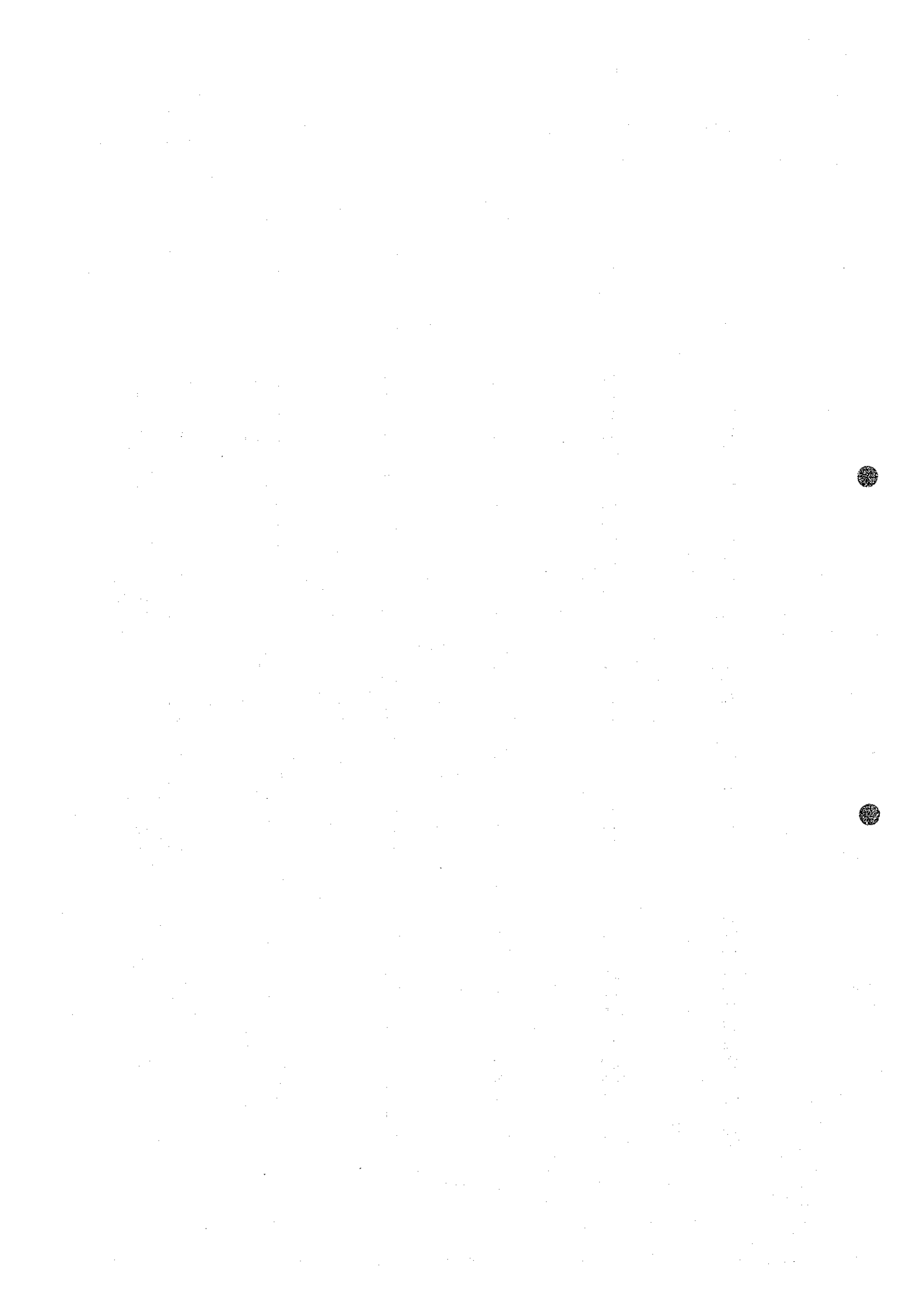
Apex. 3-7

Charts of X-ray diffraction
and fluorescence

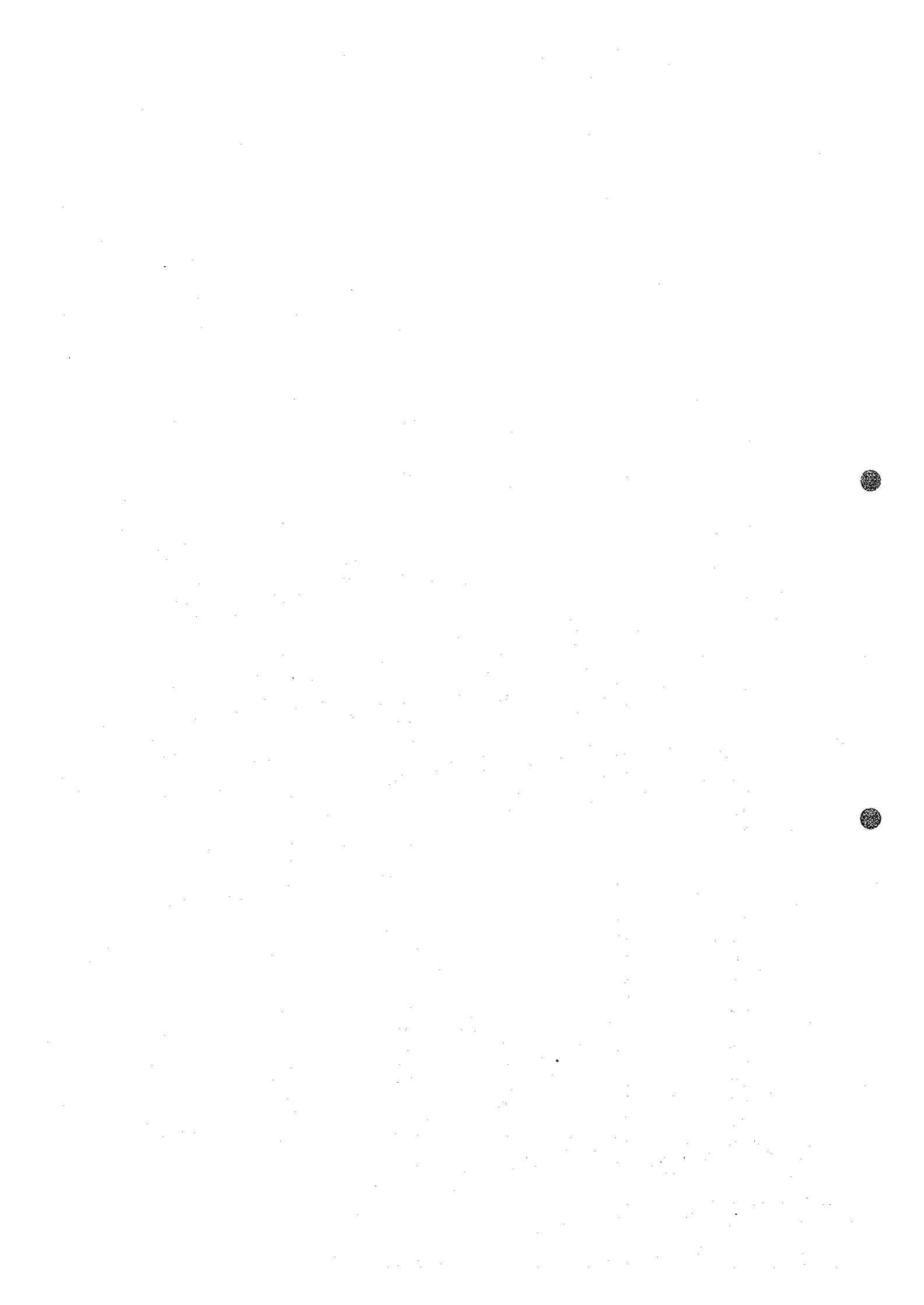
Sample S-79



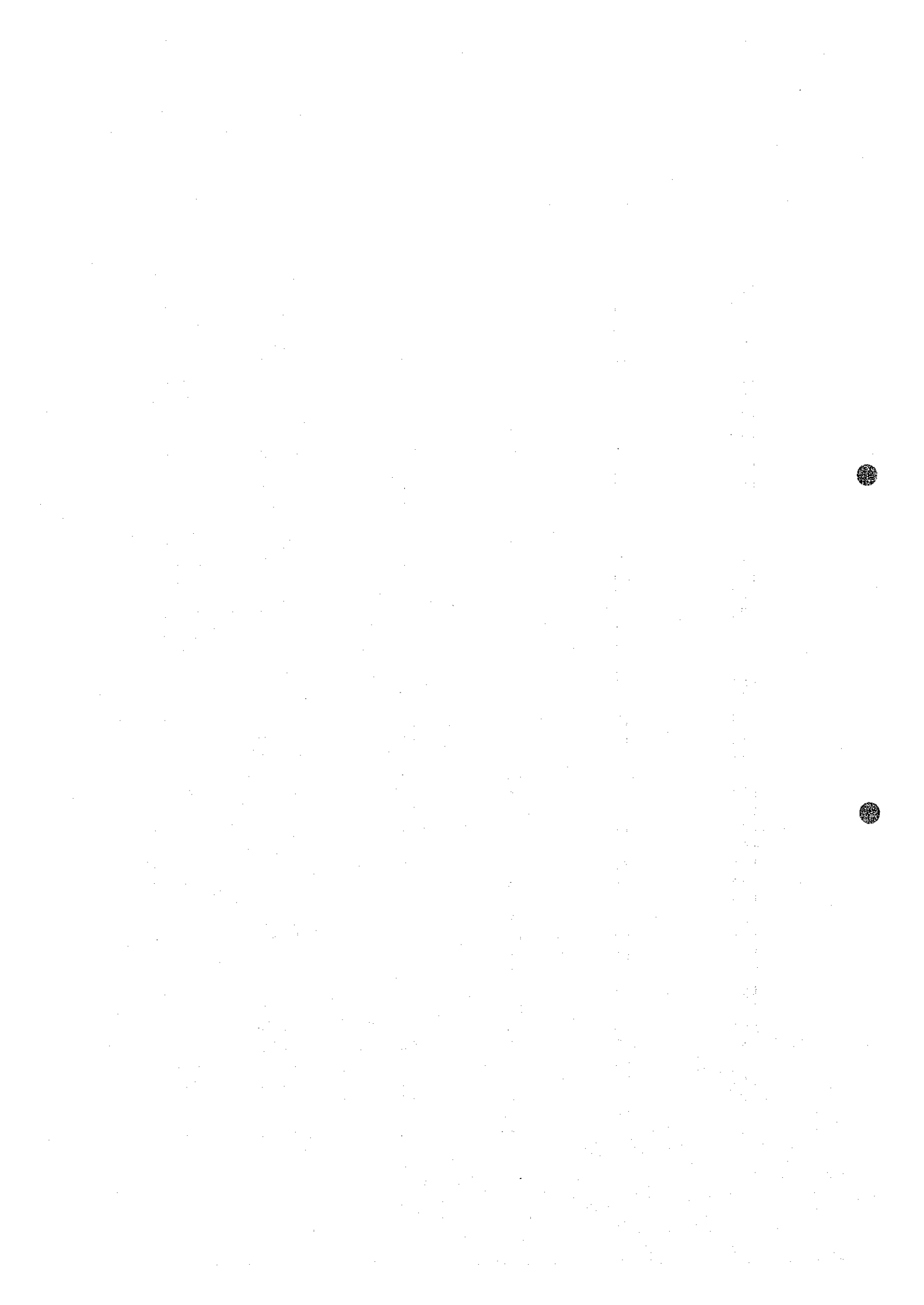
SAMPLE NO.	GEOCHEMICAL VALUE IN PPM			COORDINATION	
	CU	PB	ZN	X	Y
1	31	8	41	1.06	30.63
2	33	5	43	1.05	30.05
3	50	5	40	1.29	30.05
4	28	5	38	1.54	30.04
5	33	5	49	1.04	29.59
6	12	4	29	1.28	29.58
7	17	4	20	1.53	29.58
8	18	4	31	1.78	29.59
9	24	7	37	2.03	29.58
10	50	10	47	1.02	28.97
11	52	7	48	1.27	28.97
12	48	10	44	1.53	28.97
13	43	8	42	1.77	28.97
14	50	7	53	2.02	28.97
15	54	9	41	0.99	28.43
16	44	9	38	1.49	28.43
17	20	4	23	1.98	28.43
18	20	5	30	2.48	28.43
19	33	6	35	0.97	27.97
20	24	7	29	1.48	27.96
21	30	8	37	1.97	27.95
22	31	8	40	2.47	27.95
23	31	8	33	2.97	27.95
24	38	7	41	0.97	27.44
25	57	10	40	1.47	27.44
26	30	7	37	1.97	27.44
27	25	5	37	2.47	27.44
28	9	4	22	2.96	27.44
29	47	6	38	3.47	27.43
30	29	9	28	0.97	27.17
31	34	11	36	1.45	27.13
32	20	7	36	1.92	27.11
33	25	9	37	2.39	27.07
34	28	6	38	2.87	27.05
35	33	10	39	3.34	27.02
36	58	7	44	3.81	26.99
37	30	12	36	0.97	26.40
38	18	7	31	1.44	26.42
39	22	5	40	1.91	26.44
40	29	6	43	2.39	26.46
41	28	7	44	2.86	26.48
42	16	4	33	3.33	26.49
43	26	6	29	3.81	26.52
44	32	6	52	4.29	26.53
45	35	8	37	1.15	25.86
46	20	7	28	1.65	25.82
47	24	8	38	2.14	25.79
48	11	3	19	2.63	25.76
49	14	5	21	3.12	25.73
50	21	7	28	3.61	25.70



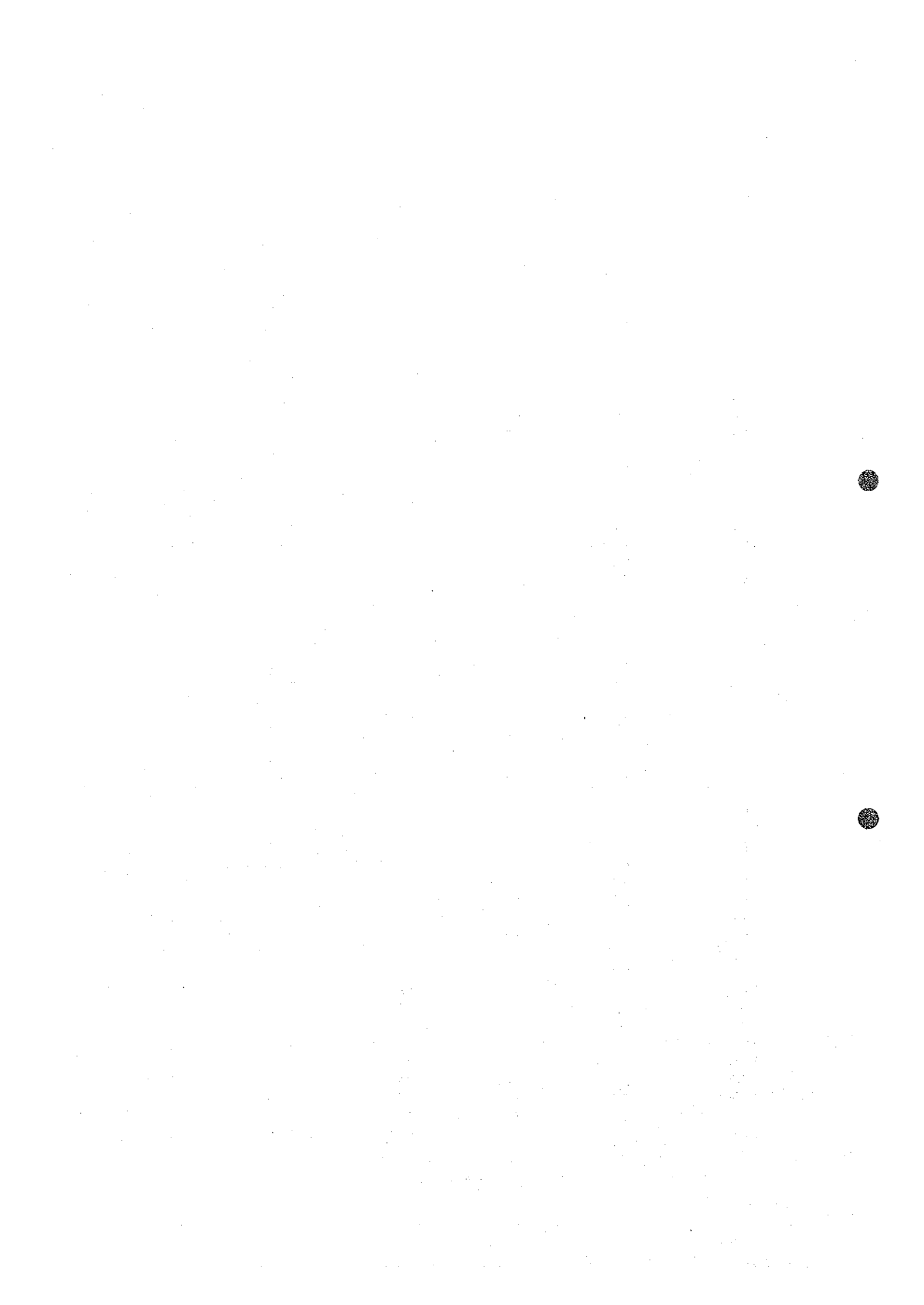
SAMPLE NO.	GIGMETICAL VALUE IN PPM			COORDINATION	
	CU	PB	ZN	X	Y
51	21	6	28	4.10	25.67
52	17	5	29	4.58	25.64
53	23	9	33	5.07	25.61
54	21	9	45	0.96	25.45
55	20	6	29	1.46	25.40
56	12	3	18	1.95	25.35
57	23	8	30	2.45	25.31
58	21	5	31	2.95	25.26
59	18	5	28	3.44	25.20
60	20	6	42	3.93	25.16
61	10	5	25	4.43	25.11
62	18	10	32	4.93	25.06
63	21	10	34	5.43	25.01
64	13	5	23	0.97	24.85
65	21	6	31	1.51	24.91
66	24	6	39	2.03	24.90
67	32	5	35	2.58	24.85
68	28	6	31	3.12	24.84
69	34	5	38	3.47	24.83
70	27	6	34	3.97	24.83
71	43	12	40	4.47	24.82
72	13	48	30	4.97	24.82
73	13	7	29	5.47	24.83
74	17	6	31	0.96	24.39
75	24	15	30	1.50	24.37
76	35	6	29	2.03	24.36
77	31	9	37	2.58	24.34
78	59	8	46	3.11	24.23
79	72	7	57	3.49	24.18
80	35	8	45	3.98	24.21
81	40	14	38	4.48	24.26
82	23	6	35	4.98	24.28
83	27	9	34	5.48	24.32
84	49	11	45	5.98	24.32
85	36	13	32	0.95	24.00
86	46	12	30	1.44	24.00
87	28	7	23	1.69	24.00
88	38	12	34	1.94	24.00
89	20	7	30	2.18	24.00
90	12	5	21	2.44	23.99
91	18	8	27	2.93	23.99
92	21	9	37	3.43	23.99
93	70	6	47	3.93	23.99
94	62	9	56	4.43	23.99
95	60	7	52	4.94	23.98
96	24	5	38	5.43	23.98
97	25	6	37	5.93	23.97
98	25	9	37	6.44	23.98
99	56	8	35	0.94	23.49
100	14	4	23	1.43	23.49



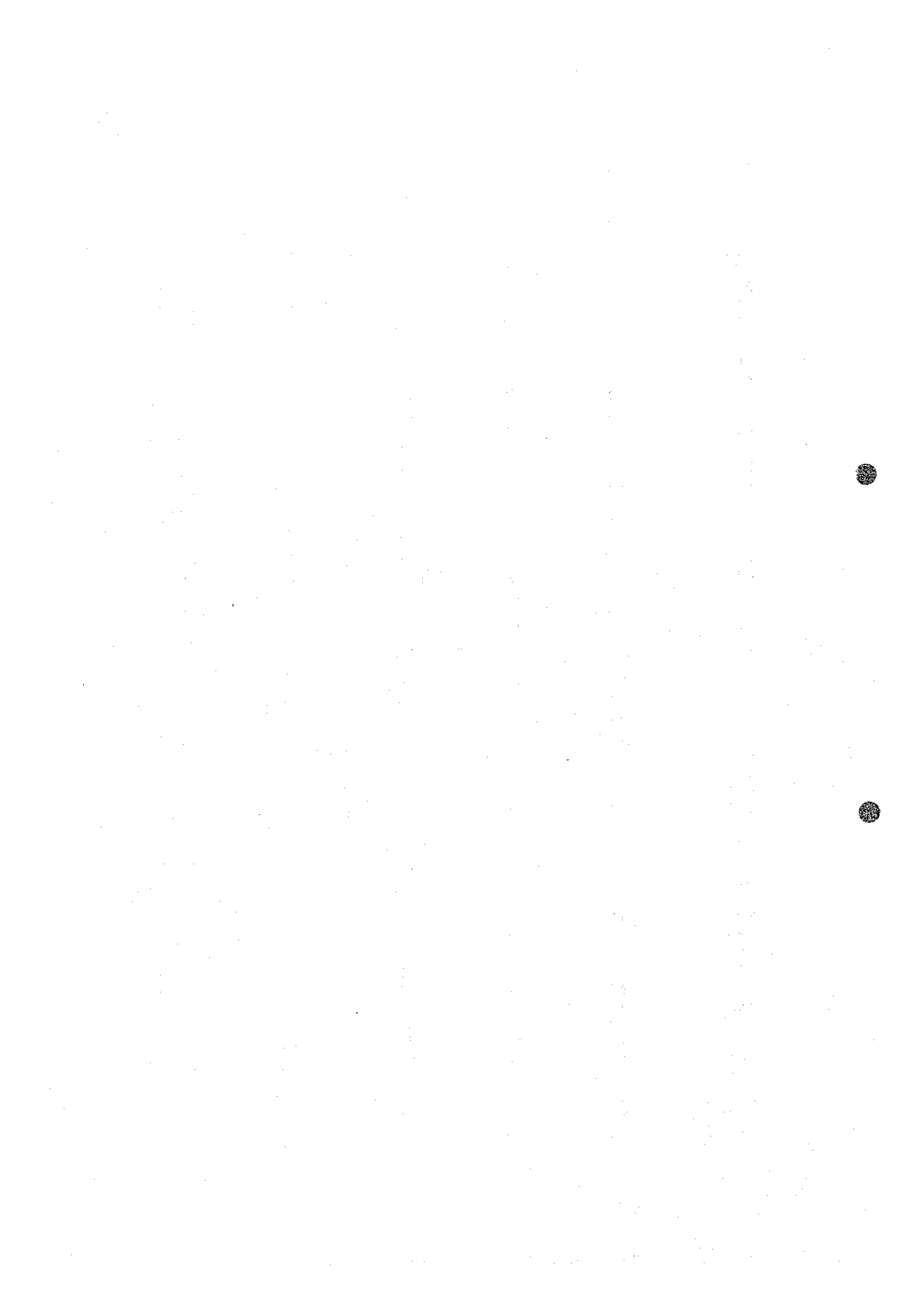
SAMPLE NO.	GIOMETICAL VALUE IN PPM			COORDINATION	
	CU	PB	ZN	X	Y
101	51	11	38	1.67	23.49
102	22	7	32	1.93	23.48
103	15	4	25	2.18	23.48
104	27	7	28	2.43	23.48
105	26	7	29	2.93	23.48
106	38	6	32	3.43	23.47
107	28	9	31	3.93	23.47
108	28	9	45	4.43	23.47
109	21	6	34	4.92	23.47
110	19	5	36	5.42	23.47
111	25	5	46	5.92	23.47
112	38	9	50	6.42	23.46
113	81	8	36	6.91	23.47
114	58	9	45	0.92	22.96
115	122	10	52	1.38	22.95
116	43	9	42	1.62	22.94
117	32	6	33	1.86	22.94
118	57	9	42	2.09	22.93
119	27	7	28	2.32	22.92
120	27	7	36	2.79	22.91
121	28	5	31	3.43	22.97
122	31	9	41	3.92	22.97
123	41	10	45	4.43	22.96
124	21	10	37	4.92	22.97
125	53	14	62	5.41	22.97
126	39	9	48	5.92	22.97
127	10	5	19	6.42	22.97
128	11	3	16	6.91	22.97
129	53	10	50	7.41	22.97
130	39	10	37	0.94	22.49
131	26	5	29	1.41	22.41
132	33	7	36	1.88	22.42
133	41	8	51	2.35	22.43
134	22	6	25	2.81	22.44
135	35	8	39	3.41	22.47
136	43	13	42	3.92	22.47
137	39	15	40	4.42	22.48
138	34	15	33	4.93	22.47
139	27	13	41	5.42	22.47
140	36	15	30	5.92	22.47
141	53	10	41	6.41	22.47
142	52	9	47	6.91	22.48
143	24	13	48	7.41	22.48
144	26	10	44	7.91	22.48
145	28	8	40	0.93	21.92
146	14	4	34	1.40	21.91
147	36	6	45	1.87	21.90
148	29	6	31	2.35	21.89
149	30	8	36	2.81	21.98
150	29	5	29	3.48	21.98



SAMPLE NO.	GIOMETICAL VALUE IN PPM			COORDINATION	
	CU	PB	ZN	X	Y
151	55	13	39	3.98	21.98
152	25	8	33	4.48	21.97
153	37	9	40	4.98	21.97
154	45	11	36	5.48	21.97
155	43	11	39	5.97	21.96
156	22	11	34	6.47	21.95
157	127	16	51	6.97	21.95
158	29	7	48	7.46	21.95
159	15	7	32	7.96	21.95
160	29	10	40	8.46	21.94
161	46	5	46	0.90	21.47
162	22	4	31	1.30	21.47
163	17	7	24	1.81	21.48
164	19	7	29	2.32	21.48
165	24	6	33	2.84	21.49
166	21	10	29	3.48	21.49
167	44	25	36	3.98	21.49
168	82	10	57	4.48	21.49
169	77	10	57	4.98	21.49
170	60	10	46	5.47	21.48
171	15	7	20	5.97	21.48
172	12	5	17	6.50	21.41
173	59	11	46	7.00	21.42
174	19	5	25	7.49	21.42
175	26	8	38	8.00	21.43
176	21	8	35	8.49	21.44
177	22	5	28	0.89	21.03
178	41	9	39	1.41	20.99
179	29	6	36	1.92	20.95
180	13	4	35	2.40	20.92
181	19	5	43	2.89	20.89
182	56	7	43	3.46	21.02
183	12	8	20	3.98	21.02
184	32	10	38	4.48	21.02
185	47	11	37	4.98	20.97
186	30	8	40	5.47	20.94
187	83	11	54	5.98	20.90
188	29	12	29	6.47	20.87
189	65	11	37	7.00	21.02
190	55	11	40	7.49	21.05
191	30	5	23	7.99	21.07
192	31	9	36	8.49	21.10
193	42	9	32	8.99	21.12
194	27	12	28	0.89	20.53
195	51	16	44	1.39	20.52
196	37	16	33	1.90	20.49
197	31	8	29	2.38	20.47
198	72	13	44	2.89	20.43
199	72	10	46	3.46	20.53
200	47	14	41	3.96	20.50



SAMPLE NO.	GIDMETICAL VALUE IN PPM			COORDINATION	
	CU	PB	ZN	X	Y
201	43	10	52	4.45	20.48
202	24	9	25	4.98	20.47
203	24	9	31	5.45	20.46
204	16	5	21	5.92	20.46
205	20	7	25	6.41	20.47
206	21	6	30	6.99	20.50
207	24	6	29	7.49	20.50
208	22	6	26	8.00	20.51
209	21	7	27	8.52	20.52
210	24	6	27	9.02	20.54
211	79	9	47	9.52	20.55
212	20	7	27	0.89	20.06
213	34	9	40	1.38	20.04
214	24	8	30	1.87	20.02
215	28	7	23	2.35	20.00
216	26	9	33	2.86	19.99
217	42	9	42	3.48	20.01
218	46	7	34	3.99	20.00
219	33	8	25	4.48	19.98
220	29	13	31	4.98	19.97
221	29	9	29	5.49	19.96
222	32	10	26	5.98	19.94
223	37	12	27	6.47	19.93
224	26	8	22	6.98	20.01
225	36	10	32	7.49	20.01
226	27	9	24	8.00	20.00
227	31	12	26	8.51	19.99
228	36	10	31	9.01	19.99
229	29	9	27	9.52	19.98
230	22	5	29	10.03	19.97
231	39	9	54	0.88	19.57
232	34	8	41	1.37	19.53
233	19	5	34	1.87	19.52
234	20	7	32	2.11	19.53
235	20	5	27	2.36	19.52
236	18	4	25	2.61	19.50
237	26	5	30	2.86	19.50
238	46	9	42	3.43	19.50
239	30	8	37	3.93	19.50
240	35	8	38	4.45	19.51
241	18	16	40	4.94	19.51
242	37	14	41	5.43	19.50
243	22	10	27	5.95	19.50
244	40	13	38	6.46	19.49
245	35	10	33	6.98	19.49
246	30	8	38	7.47	19.50
247	22	7	34	7.97	19.50
248	56	9	38	8.47	19.50
249	50	13	41	8.97	19.50
250	43	10	35	9.46	19.50



SAMPLE NO.	GIOMETICAL VALUE IN PPM			COORDINATION	
	CU	PB	ZN	X	Y
251	26	5	32	9.96	19.50
252	30	8	34	10.20	19.50
253	34	10	36	10.46	19.50
254	55	8	44	0.87	19.03
255	32	5	42	1.11	19.02
256	23	4	34	1.37	19.03
257	13	5	58	1.61	19.03
258	36	6	55	1.86	19.03
259	19	5	29	2.11	19.02
260	14	5	23	2.36	19.02
261	24	8	30	2.61	19.01
262	23	4	27	2.86	19.01
263	30	5	33	3.17	19.06
264	28	4	27	3.43	19.06
265	27	5	30	3.69	19.05
266	31	9	38	3.94	19.05
267	39	7	38	4.44	19.04
268	50	10	36	4.94	19.03
269	40	12	40	5.44	19.01
270	19	8	34	5.93	19.01
271	31	11	40	6.45	19.00
272	44	16	45	6.96	18.97
273	14	5	20	7.44	18.94
274	8	3	14	7.95	18.90
275	16	3	19	8.43	18.86
276	22	4	27	8.92	18.83
277	39	10	31	9.48	19.06
278	40	13	30	9.73	19.05
279	28	6	20	9.98	19.04
280	47	10	25	10.24	19.04
281	45	13	33	10.47	19.04
282	42	9	27	10.72	19.03
283	45	13	40	10.98	19.01
284	21	5	33	0.86	18.59
285	31	4	40	1.14	18.57
286	41	8	45	1.38	18.57
287	36	6	48	1.61	18.56
288	54	10	46	1.87	18.54
289	45	10	44	2.11	18.54
290	48	11	48	2.37	18.52
291	42	10	40	2.60	18.51
292	31	11	57	2.85	18.49
293	22	4	32	3.17	18.54
294	29	7	31	3.42	18.54
295	15	5	20	3.66	18.52
296	23	8	33	3.90	18.51
297	27	8	37	4.40	18.50
298	32	10	36	4.91	18.48
299	48	12	32	5.41	18.47
300	33	14	36	5.92	18.46

