本孔では着鉱しなかったが，下部の少量の黒色チャートは断面図（Fig. Ⅱ－2－2）に示すように№14孔の着鉱部の延長と考えられる。

4－2－16　№16孔

№16孔はFig. Ⅱ－1に示すように露頭東部の下部把握を目的として実施された。ボーリング地点の地質は赤褐色泥質チャート・頁岩互層と褐色泥質チャート・頁岩互層からなり，走向N30W・傾斜70～80Sを示す。北東側に多数の鉱層がある。

ボーリング孔では孔口から孔底19.00mまで褐色チャートを主とし，5.00m～6.00m間および8.00m～9.00m間にてわずかに黒色チャートが認められた。

本孔において認められた2個所の少量の黒色チャートは地表の鉱層の下部延長と考えられる。

4－2－17　№17孔

№17孔は№16孔と同一ボーリング地点にて実施された。

ボーリング孔の地質は孔口から孔底12.00mまで褐色チャートを主とし，1.00m～10.00m間にて少量の黒色チャートが認められた。本孔では着鉱しなかったが，これらの黒色チャートは，№16孔のものに連続するものである。

4－3　結果の要約

今回のボーリング調査の結果，№9孔付近では地表から30mまで鉱層が連続することが把握された。しかし，地表の露頭が10m～15m下部で少量の黒色チャートになるということが認められ，露頭の傾斜方向の連続性は，走向方向の連続性と同様な傾向を示し，断続的で連続性に乏しいということが判明した。

また，マンガン鉱物はX線回折および顕微鏡観察により地表露頭部とほぼ同様な鉱物組み合せを示した。

着鉱部の化学分析の結果，一部で高品位鉱石が存在することが明らかとなったが，小規模であり，全体的に地表より低いマンガン品位（平均MnO_2 13.49%）を示した。しかし，Fe品位は地表部よりも高く，特に№12孔ではFe 6.28%と高い値を得た。

APPENDICES

APPENDICES

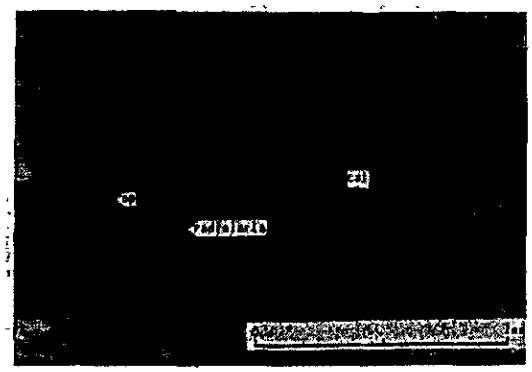
Fig. A—1 Microphotograph of Thin Section

Abbreviations

qz : quartz
pl : plagioclase
hy : hypersthene
au : augite
cal : calcite
chl : chlorite
serp : serpentine
Mn min. : manganese mineral
op : opaque mineral

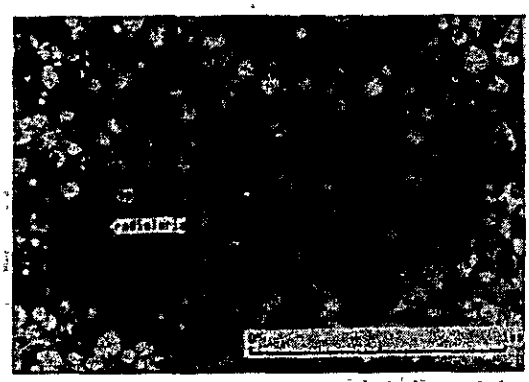
only lower polar

Sample No. : G124
Location : N2457.5, E761.0
Formation : Halfa formation (Hmr)
Rock Name : yellow chert



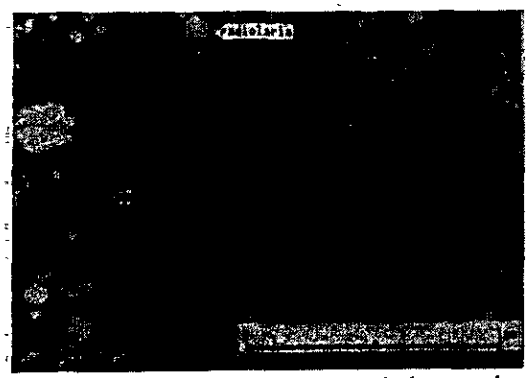
only lower polar

Sample No. : K104
Location : N2485.0, E777.5
Formation : Halfa formation (Hmw)
Rock Name : light grey chert



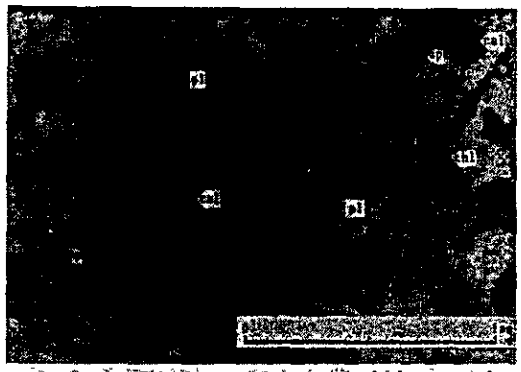
only lower polar

Sample No. : K106
Location : N2484.5, E778.5
Formation : Halfa formation (Hmr)
Rock Name : reddish brown chert

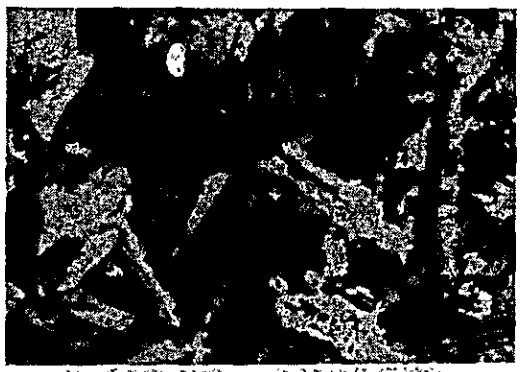


only lower polar

Sample No. : K112
Location : N2484.5, E778.5
Formation : Halfa formation (Hmr)
Rock Name : light brown muddy chert

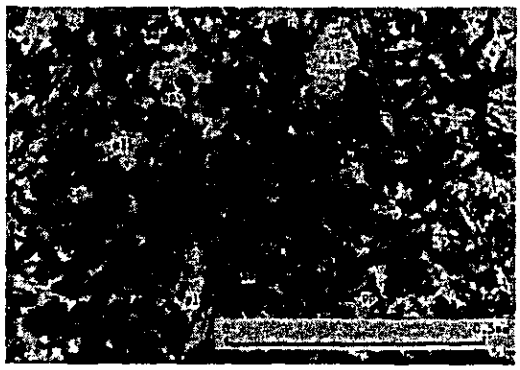


only lower polar

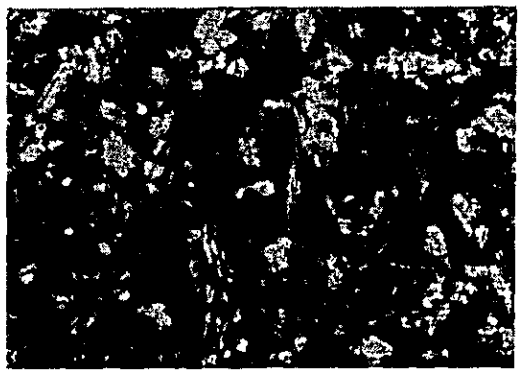


crossed ploars

Sample No. : H014
Location : N2453.5, E761.0
Rock Name : trachyandesite

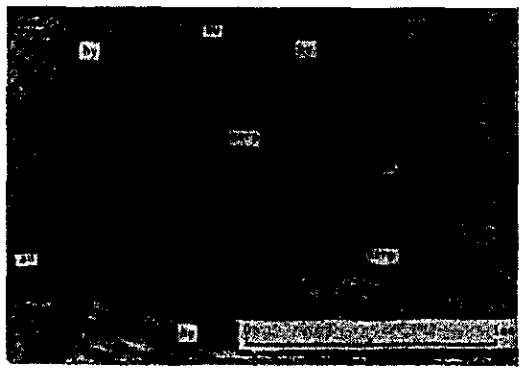


only lower polar

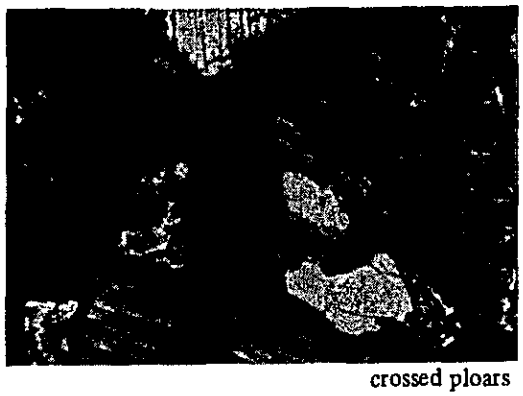


crossed ploars

Sample No. : K006
Location : N2453.5, E772.0
Rock Name : dolerite



only lower polar



crossed ploars

Sample No. : K150
Location : N2455.5, E763.5
Rock Name : Pyroxenite

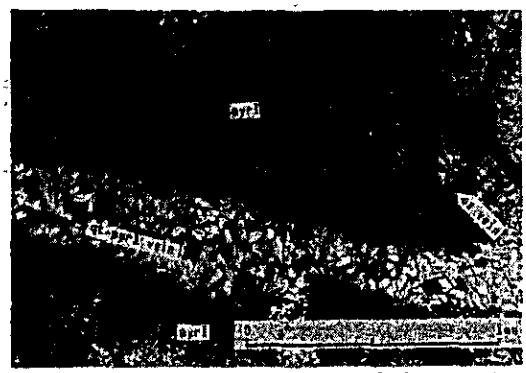
Fig. A—2 Microphotograph of Polished Section

Abbreviations

pyrl : pyrolusite

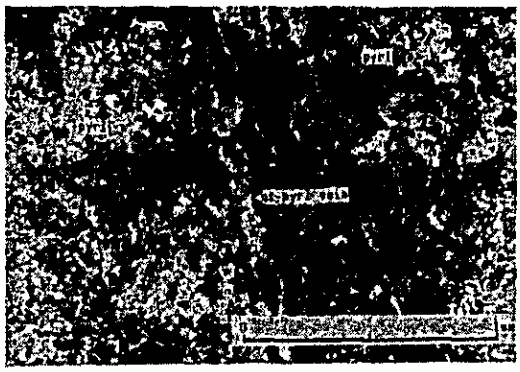
only lower polar

Sample No. : G015
Location : N2458.0, E760.5
Formation : Halfa formation (Hmr)
Ore Name : manganese ore
Type of Ore : banded



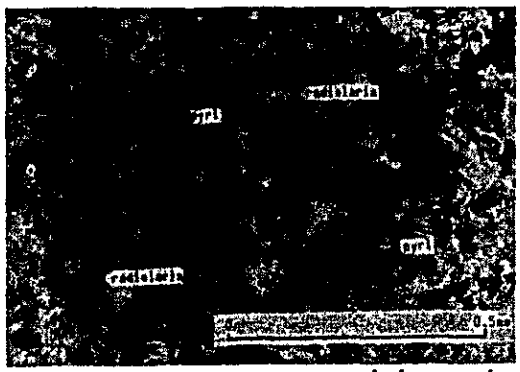
only lower polar

Sample No. : G020
Location : N2456.5, E761.0
Formation : Halfa formation (Hmr)
Ore Name : manganese ore
Type of Ore : network



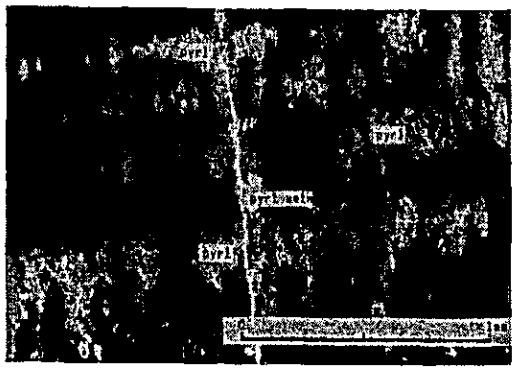
only lower polar

Sample No. : G058
Location : N2457.5, E760.5
Formation : Halfa formation (Hmr)
Ore Name : manganese ore
Type of Ore : nodular



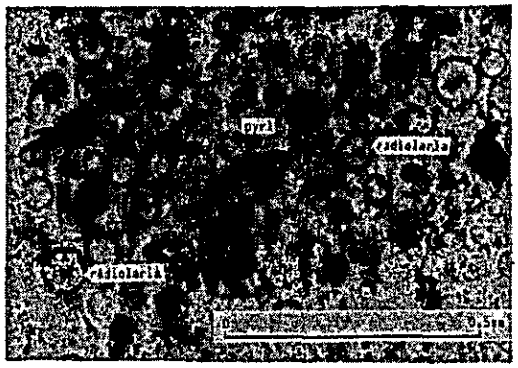
only lower polar

Sample No. : H048
Location : N2462.5, E759.5
Formation : Halfa formation (Hmr)
Ore Name : manganese ore
Type of Ore : massive



only lower polar

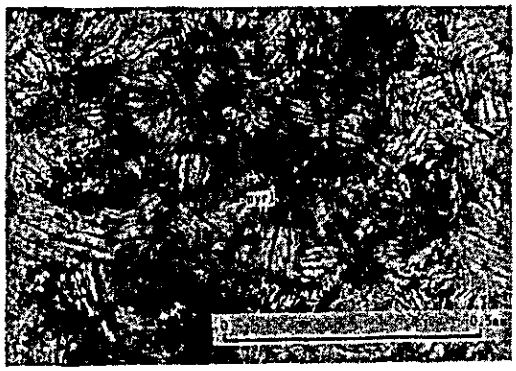
Sample No.	:	K018
Location	:	N2458.0, E758.5
Formation	:	Halfa formation
Ore Name	:	manganese ore
Type of Ore	:	fine-banded, breccieted



only lower polar

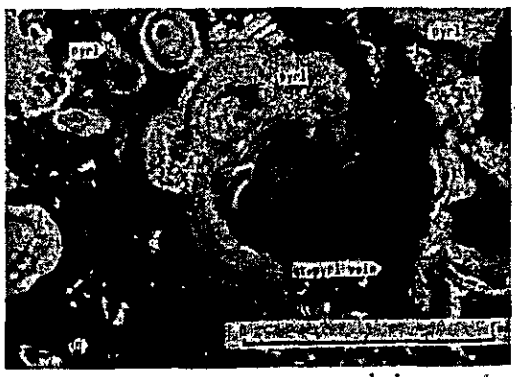
(outside of nodule)

Sample No.	:	K069
Location	:	N2455.0, E771.0
Formation	:	Halfa formation
Ore Name	:	manganese ore
Type of Ore	:	nodular



only lower polar

(inside of nodule)



only lower polar

Sample No.	:	K100
Location	:	N2484.5, E778.5
Formation	:	Halfa formation
Ore Name	:	manganese ore
Type of Ore	:	massive

Fig. A—3 Microphotograph of Fossil

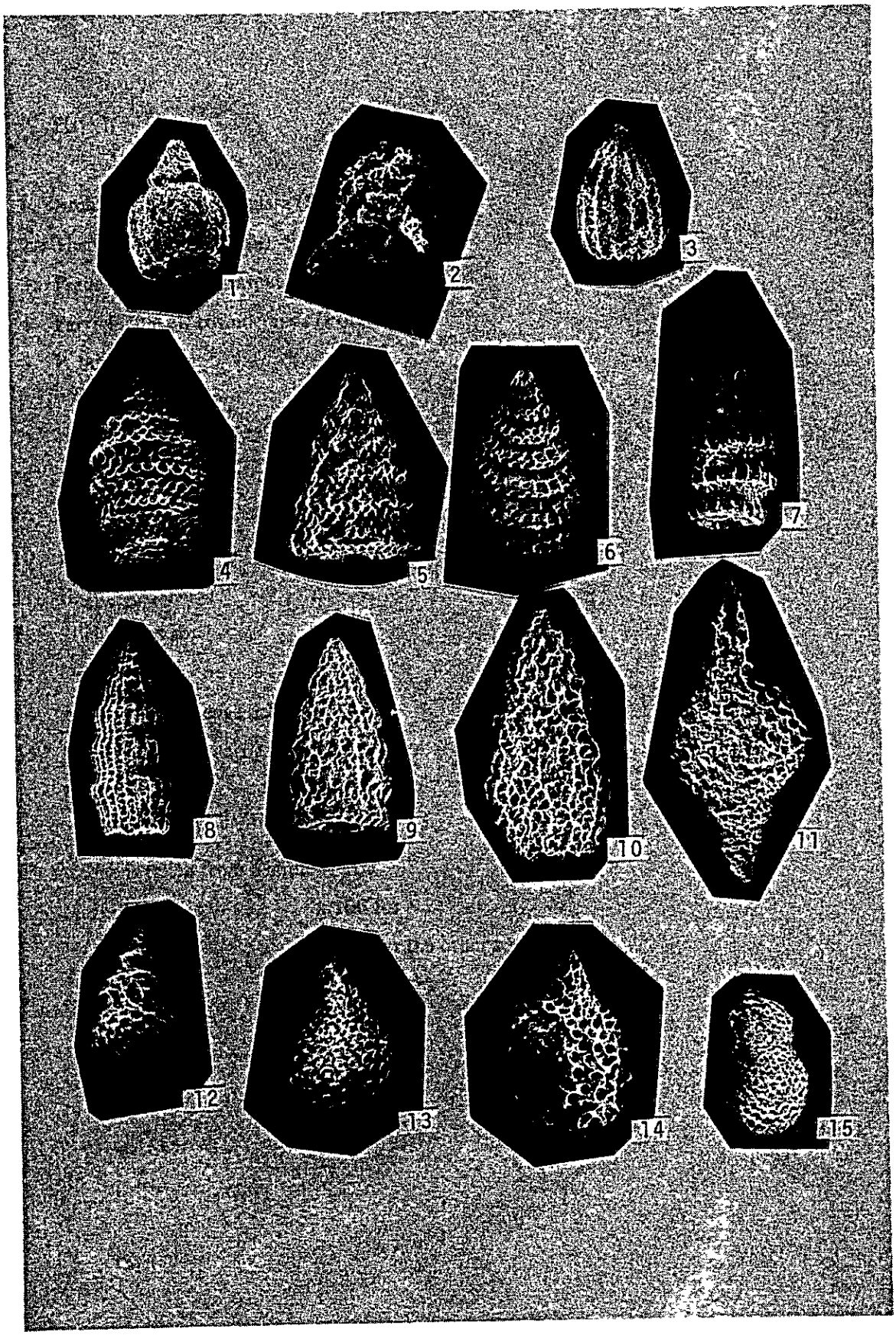
Plate I

1. Eucyrtidium(?) ptyctum Riedel and Sanfilippo
2. Saitoum sp.
3. Thanarla conica (Aliev)
4. Parvicingula boesii Parona
5. P. sp.
6. P. cf. citae Pessagno
7. Pseudodictyomitra sp.
8. Dictyomitra sp.
9. Xitus(?) sp.
10. Xitus(?) sp.
12. Sethocapsa sp.
13. S. sp.
14. S. sp.
15. Tricolocapsa sp.

All specimens taken from Sample K-106

Magnification: x 250 for No. 2

x 175 for the other specimens.


1
2
3
4
5
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7
8
9
10
11
12
13
14
15

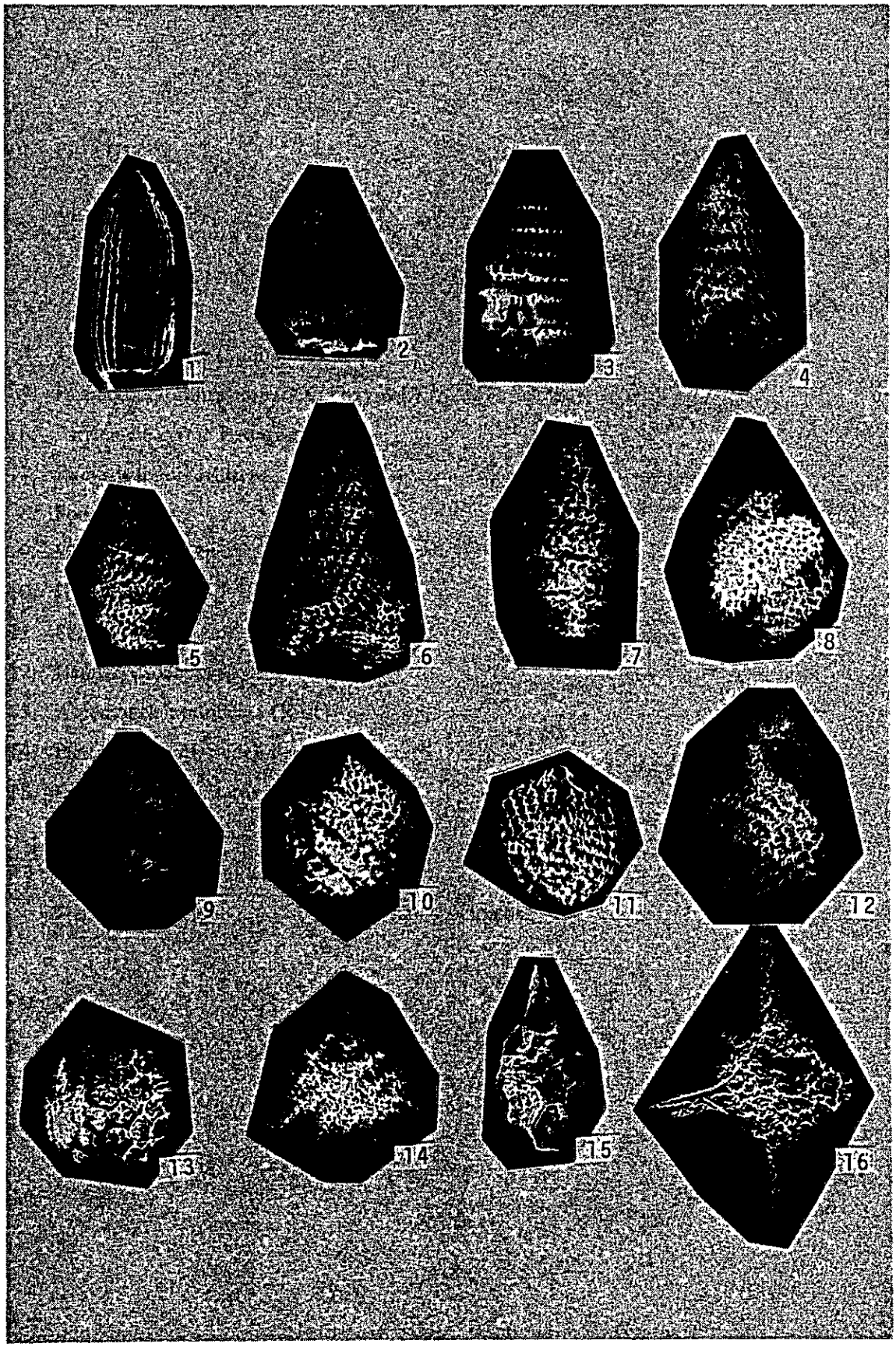
Plate II

1. Archaeodictyomitra apiara (Rust)
2. Thanarla conica (Alieve)
3. Pseudodictyomitra carpatica (Lozyniak)
4. Parvicingula cf. cosmoconica (Foreman)
5. P. boesii Parona
6. P. sp.
7. P. sp.
8. Sethocapsa sp.
9. S. sp.
10. Hemicryptocapsa sp.
11. H. sp.
12. Stichocapsa sp.
13. Gen. sp. indet.
14. Alievium cf. helenae Schaaf
15. Pantanellium cf. corriganensis Pessagno
16. Emiluvia sp.

All specimens taken from Sample K-103

Magnification: x 100 for No.4

x 175 for the other specimens


1
2
3
4
5
6
7
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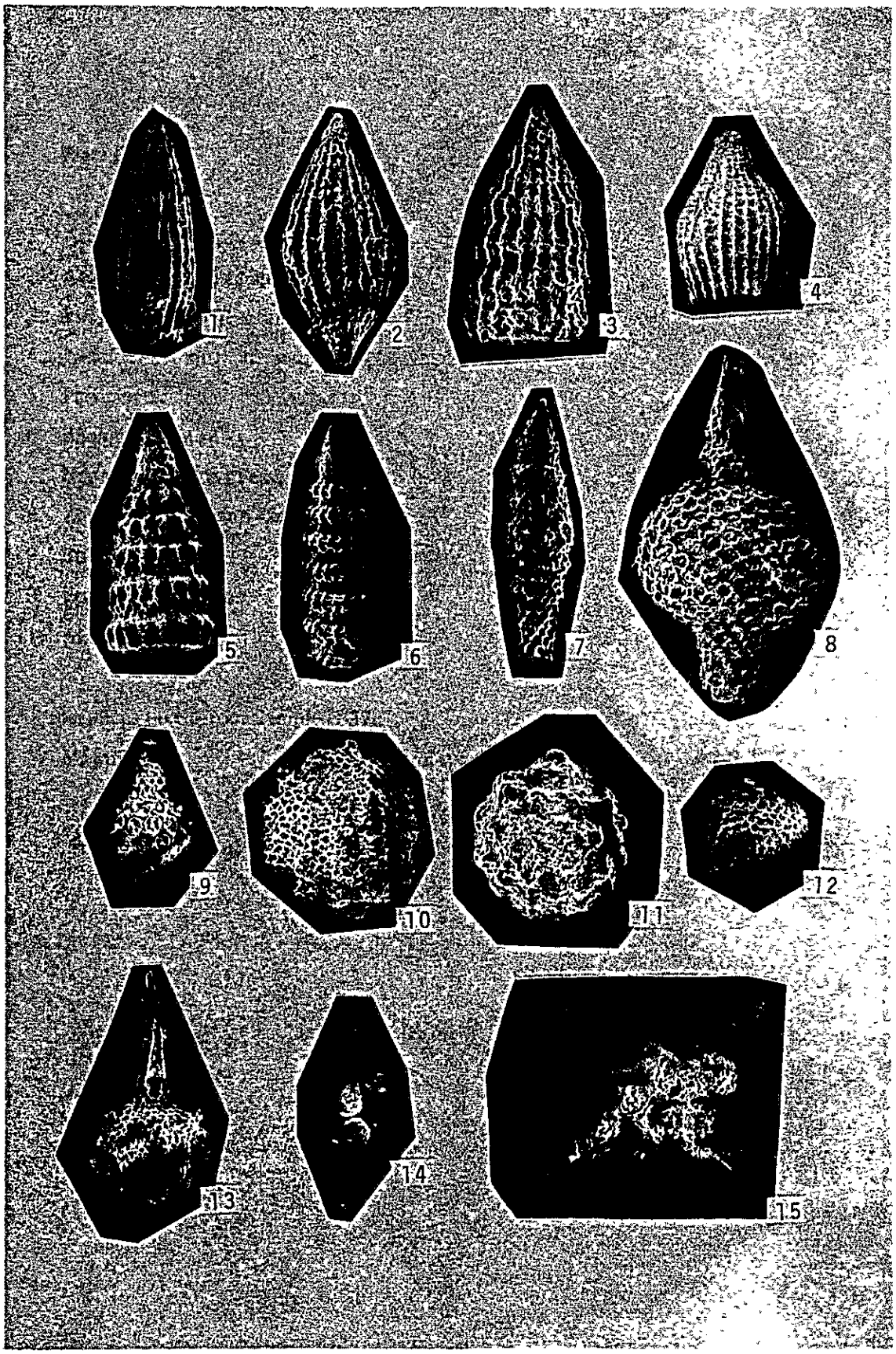
9
10
11
12
13
14
15
16

Plate III

1. Archaeodictyomitra vulgaris Pessagno
2. A. lacrimula (Foreman)
3. Dictyomitra sp.
4. Thanarla purchra (Squinabol)
5. Pseudodictyomitra carpatica (Lozyniak)
6. Parvicingula citae Pessagno
7. Eucyrtis tenuis (Rust)
8. Podobursa sp.
9. Siphocampium sp.
10. Gen. sp. indet.
11. Sethocapsa sp.
12. Hemicryptocapsa sp.
13. Acaeniotyle umbilicata (Rust)
14. Pantanellium cf. riedeli Pessagno
15. Cecrops septenporatus (Parona)

All specimens taken from Sample K-93

Magnification: x 175 for all specimens.


1
2
3
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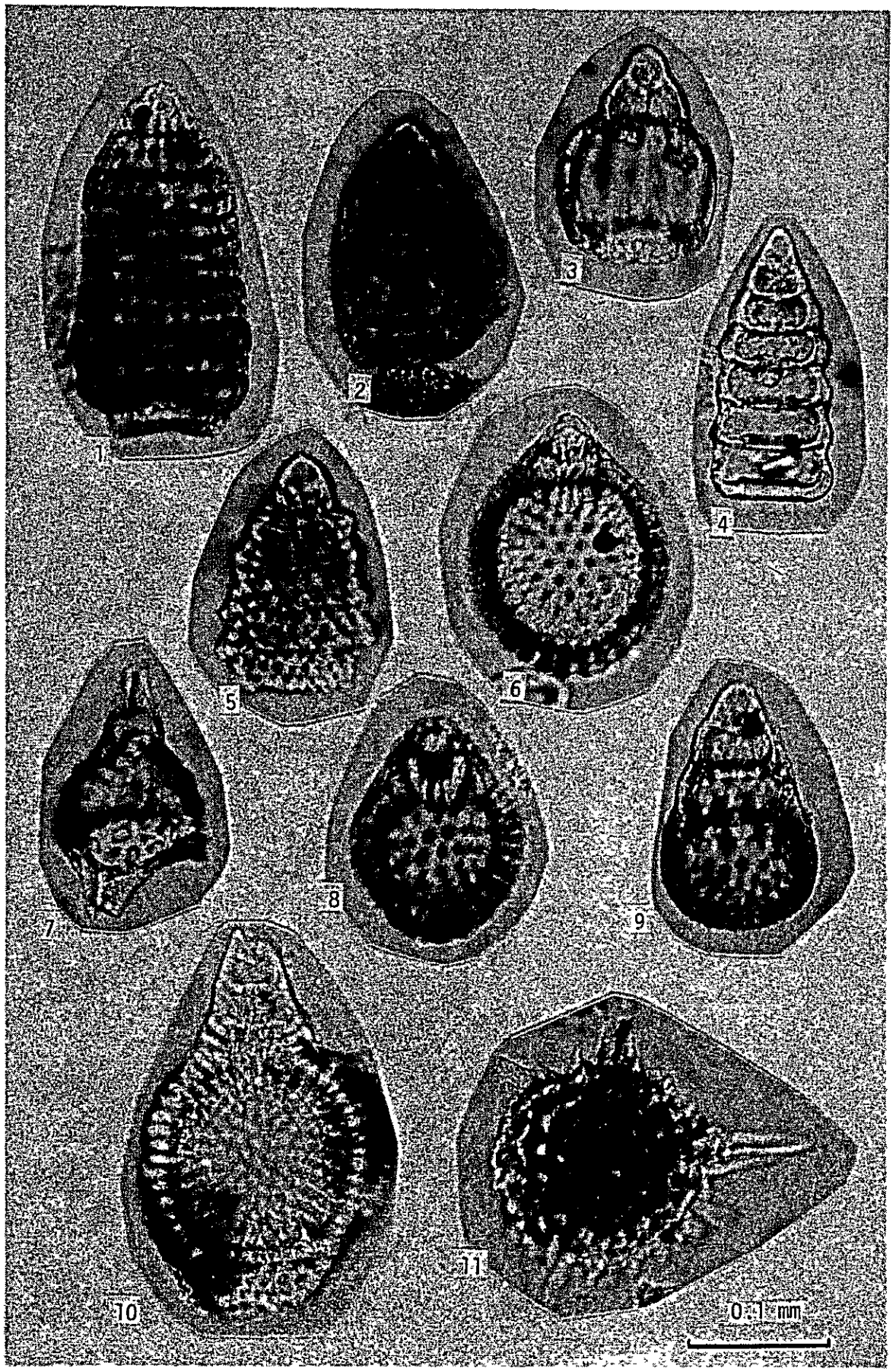
11
12
13
14
15

Plate IV

1. Archaeodictyomitra apiara (Rust)
2. Archaeodictyomitra sp.
3. Eucyrtidium (?) ptyctum Riedel and Sanfilippo
4. Pseudodictyomitra aff. carpatica (Lozyniak)
5. Parvicingula sp.
6. Zhamoidellum sp.
7. Napora aff. bukryi Pessagno
8. Zhamoidellum ovum Dumitrica
9. Stichocapsa sp.
10. Eucyringium (?) sp.
11. Alievium (?) sp.

All specimens taken from Sample H-37.

Magnification: x 260 for all specimens.


1
2
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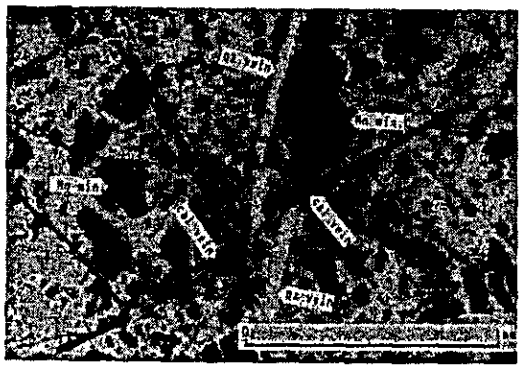
6
7
8
9
10
11
0.1 mm

APPENDICES

Fig. A—1 Microphotograph of Thin Section

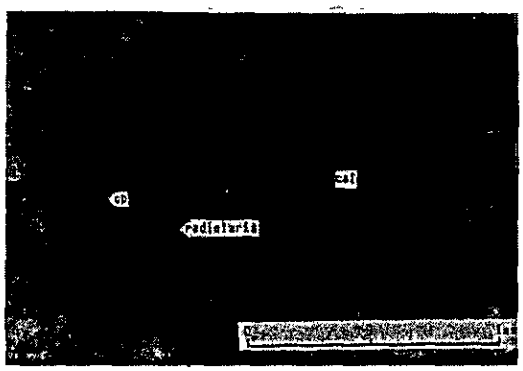
Abbreviations

qz : quartz
pl : plagioclase
hy : hypersthene
au : augite
cal : calcite
chl : chlorite
serp : serpentine
Mn min. : manganese mineral
op : opaque mineral



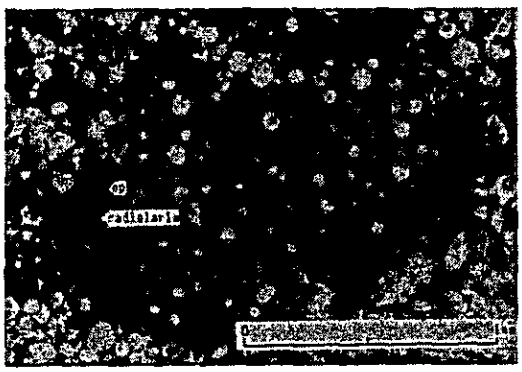
only lower polar

Sample No. : G124
Location : N2457.5, E761.0
Formation : Halfa formation (Hmr)
Rock Name : yellow chert



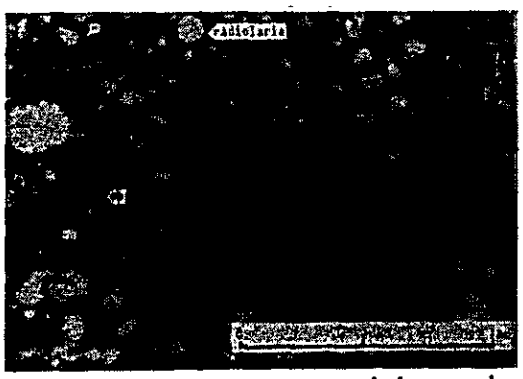
only lower polar

Sample No. : K104
Location : N2485.0, E777.5
Formation : Halfa formation (Hmw)
Rock Name : light grey chert



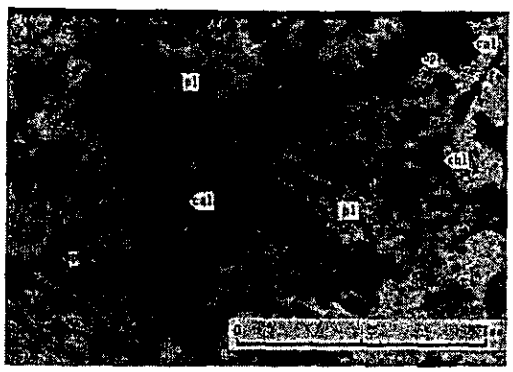
only lower polar

Sample No. : K106
Location : N2484.5, E778.5
Formation : Halfa formation (Hmr)
Rock Name : reddish brown chert

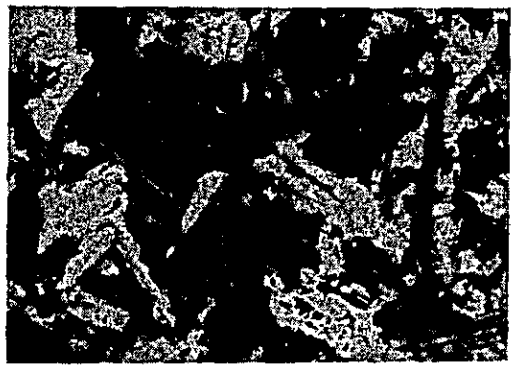


only lower polar

Sample No. : K112
Location : N2484.5, E778.5
Formation : Halfa formation (Hmr)
Rock Name : light brown muddy chert

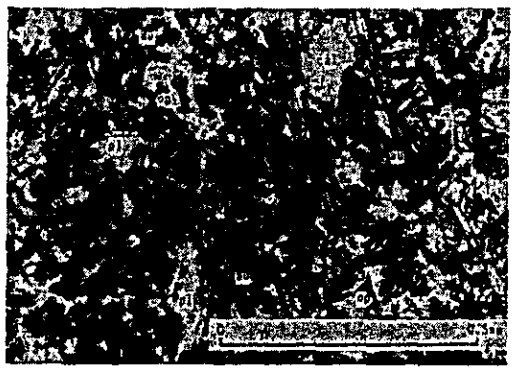


only lower polar



crossed ploars

Sample No. : H014
Location : N2453.5, E761.0
Rock Name : trachyandesite



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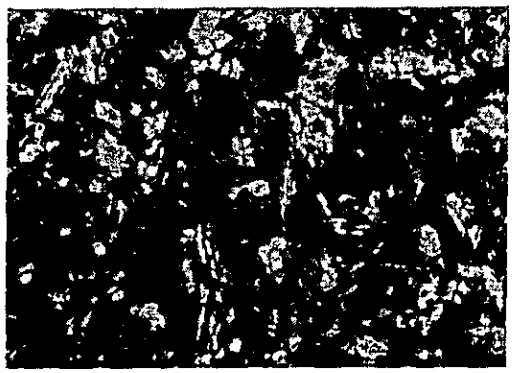
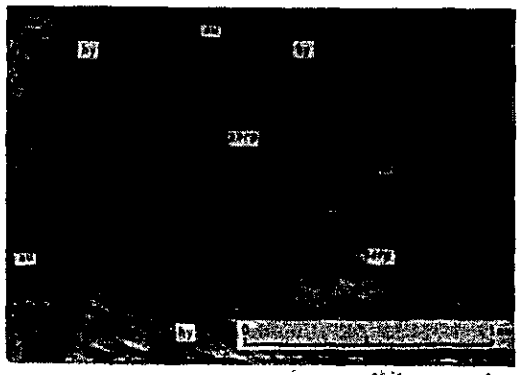


crossed ploars

Sample No. : K006
Location : N2453.5, E772.0
Rock Name : dolerite



only lower polar

crossed ploars

Sample No. : K150
Location : N2455.5, E763.5
Rock Name : Pyroxenite

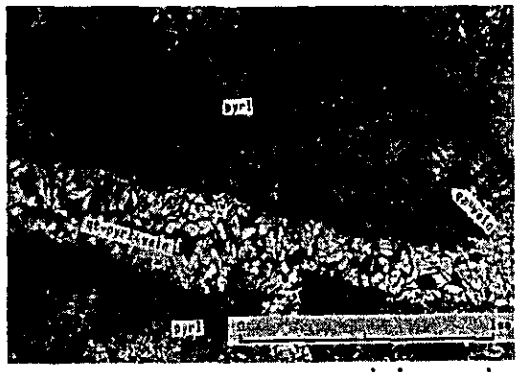
Fig. A—2 Microphotograph of Polished Section

Abbreviations

pyrl : pyrolusite

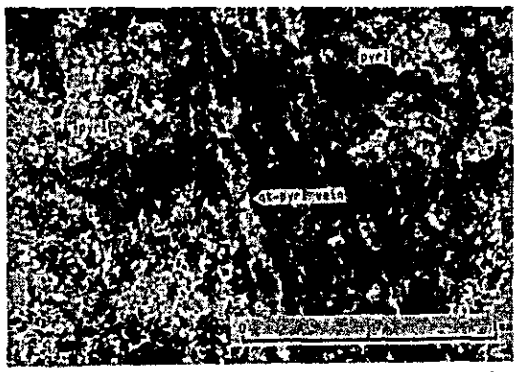
only lower polar

Sample No. : G015
Location : N2458.0, E760.5
Formation : Halfa formation (Hmr)
Ore Name : manganese ore
Type of Ore : banded



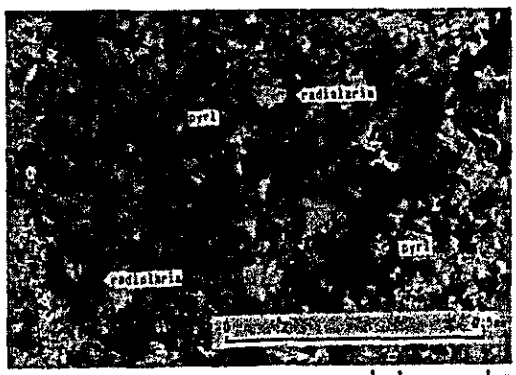
only lower polar

Sample No. : G020
Location : N2456.5, E761.0
Formation : Halfa formation (Hmr)
Ore Name : manganese ore
Type of Ore : network



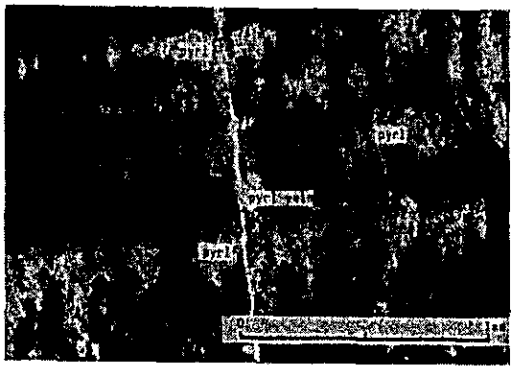
only lower polar

Sample No. : G058
Location : N2457.5, E760.5
Formation : Halfa formation (Hmr)
Ore Name : manganese ore
Type of Ore : nodular



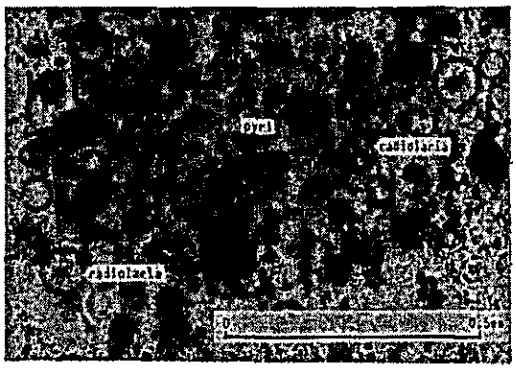
only lower polar

Sample No. : H048
Location : N2462.5, E759.5
Formation : Halfa formation (Hmr)
Ore Name : manganese ore
Type of Ore : massive



only lower polar

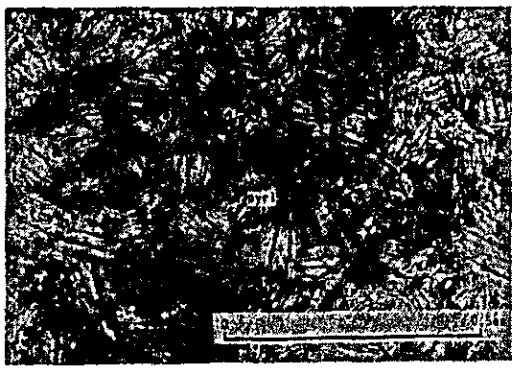
Sample No.	:	K018
Location	:	N2458.0, E758.5
Formation	:	Halfa formation
Ore Name	:	manganese ore
Type of Ore	:	fine-banded, breccieted



only lower polar

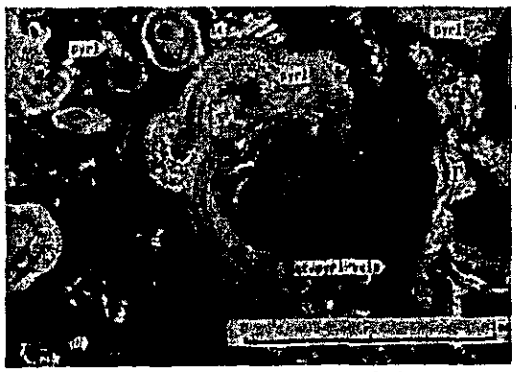
(outside of nodule)

Sample No.	:	K069
Location	:	N2455.0, E771.0
Formation	:	Halfa formation
Ore Name	:	manganese ore
Type of Ore	:	nodular



only lower polar

(inside of nodule)



only lower polar

Sample No.	:	K100
Location	:	N2484.5, E778.5
Formation	:	Halfa formation
Ore Name	:	manganese ore
Type of Ore	:	massive

Fig. A—3 Microphotograph of Fossil

Plate I

1. Eucyrtidium(?) ptyctum Riedel and Sanfilippo
2. Saitoum sp.
3. Thanarla conica (Aliev)
4. Parvicingula boesii Parona
5. P. sp.
6. P. cf. citae Pessagno
7. Pseudodictyomitra sp.
8. Dictyomitra sp.
9. Xitus(?) sp.
10. Xitus(?) sp.
12. Sethocapsa sp.
13. S. sp.
14. S. sp.
15. Tricolocapsa sp.

All specimens taken from Sample K-106

Magnification: x 250 for No. 2

x 175 for the other specimens.

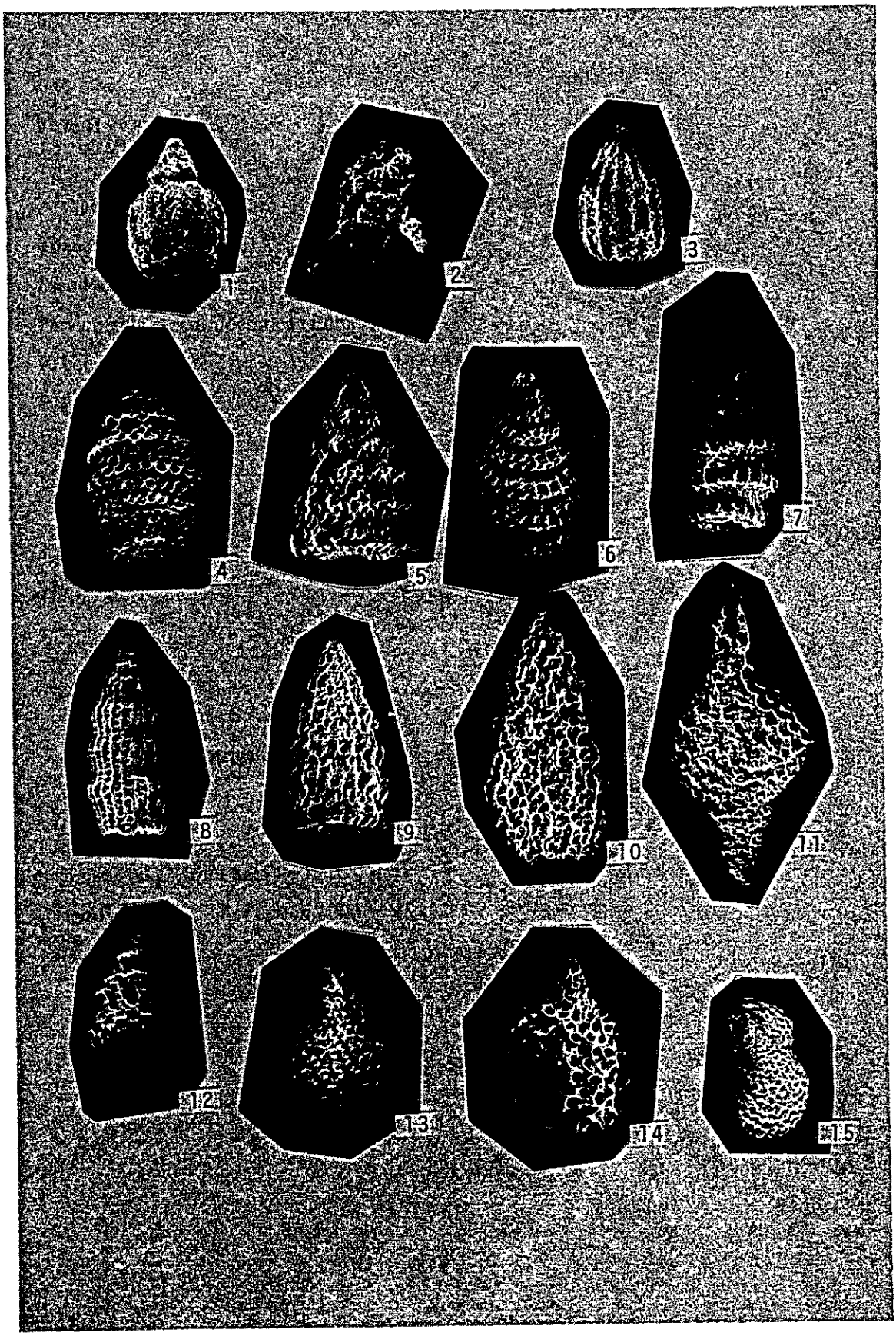

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

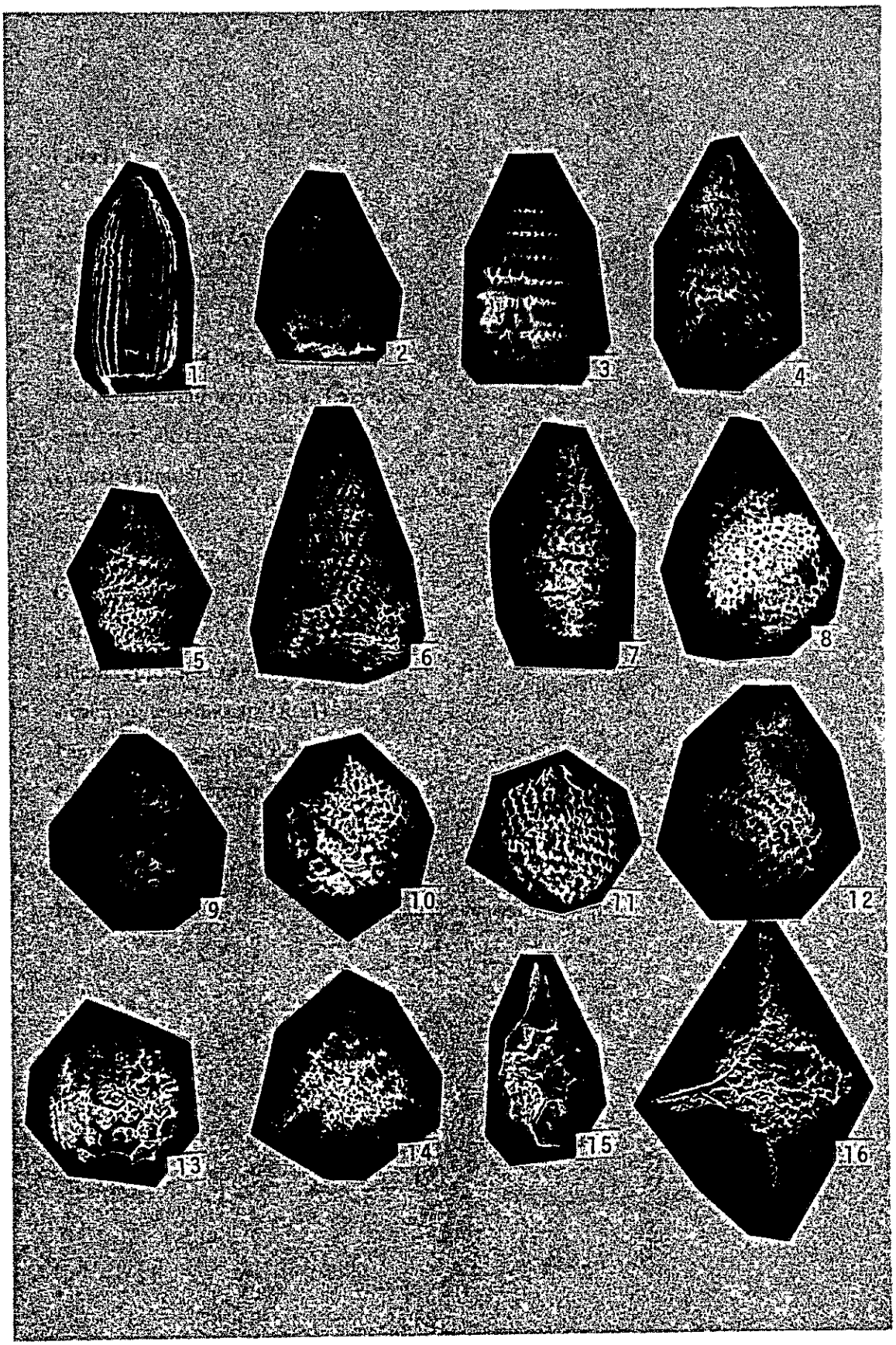
Plate II

1. Archaeodictyomitra apiara (Rust)
2. Thanarla conica (Alieve)
3. Pseudodictyomitra carpatica (Lozyniak)
4. Parvicingula cf. cosmoconica (Foreman)
5. P. boesii Parona
6. P. sp.
7. P. sp.
8. Sethocapsa sp.
9. S. sp.
10. Hemicryptocapsa sp.
11. H. sp.
12. Stichocapsa sp.
13. Gen. sp. indet.
14. Alievium cf. helenae Schaaf
15. Pantanellium cf. corriganensis Pessagno
16. Emiluvia sp.

All specimens taken from Sample K-103

Magnification: x 100 for No.4

x 175 for the other specimens


1
2
3
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5
6
7
8
9
10
11
12
13
14
15
16

Plate III

1. Archaeodictyomitra vulgaris Pessagno
2. A. lacrimula (Foreman)
3. Dictyomitra sp.
4. Thanarla purchra (Squinabol)
5. Pseudodictyomitra carpatica (Lozyniak)
6. Parvicingula citae Pessagno
7. Eucyrtis tenuis (Rust)
8. Podobursa sp.
9. Siphocampium sp.
10. Gen. sp. indet.
11. Sethocapsa sp.
12. Hemicryptocapsa sp.
13. Acaeniotyle umbilicata (Rust)
14. Pantanellium cf. riedeli Pessagno
15. Cecrops septenporatus (Parona)

All specimens taken from Sample K-93

Magnification: x 175 for all specimens.

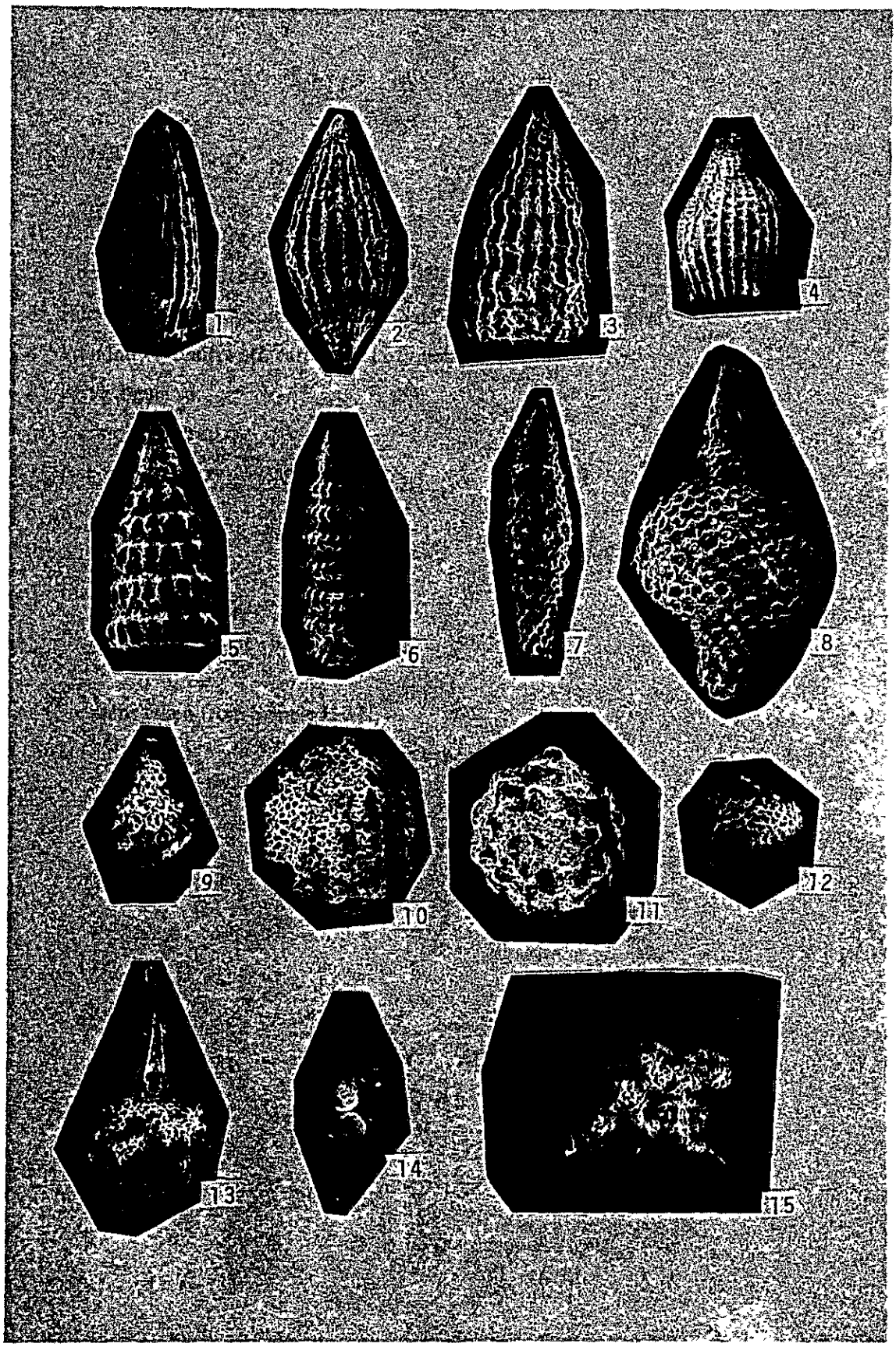

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Plate IV

1. Archaeodictyomitra apiara (Rust)
2. Archaeodictyomitra sp.
3. Eucyrtidium (?) ptyctum Riedel and Sanfilippo
4. Pseudodictyomitra aff. carpatica (Lozyniak)
5. Parvicingula sp.
6. Zhamoidellum sp.
7. Napora aff. bukryi Pessagno
8. Zhamoidellum ovum Dumitrica
9. Stichocapsa sp.
10. Eucyringium (?) sp.
11. Alievium (?) sp.

All specimens taken from Sample H-37.

Magnification: x 260 for all specimens.

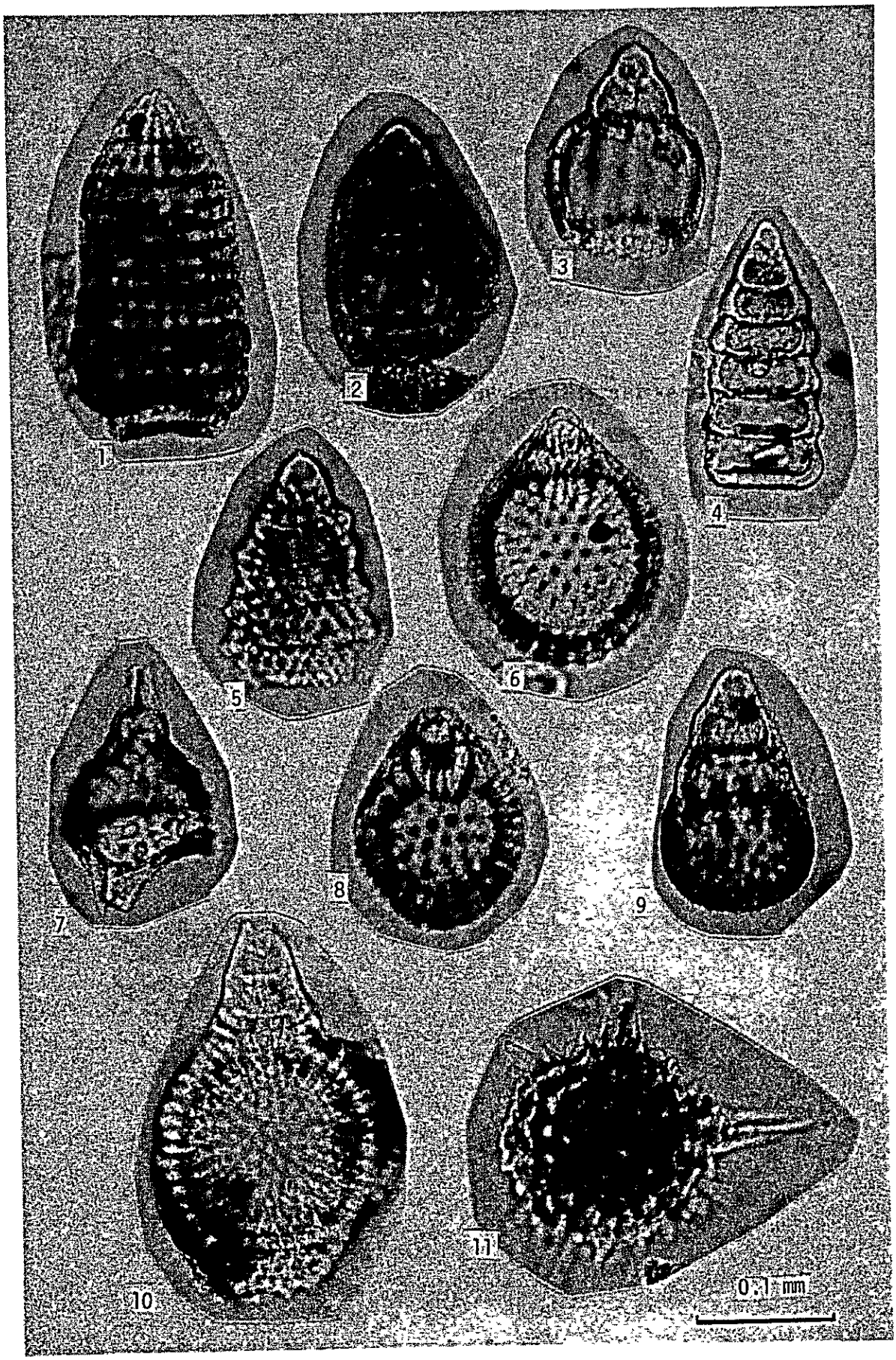
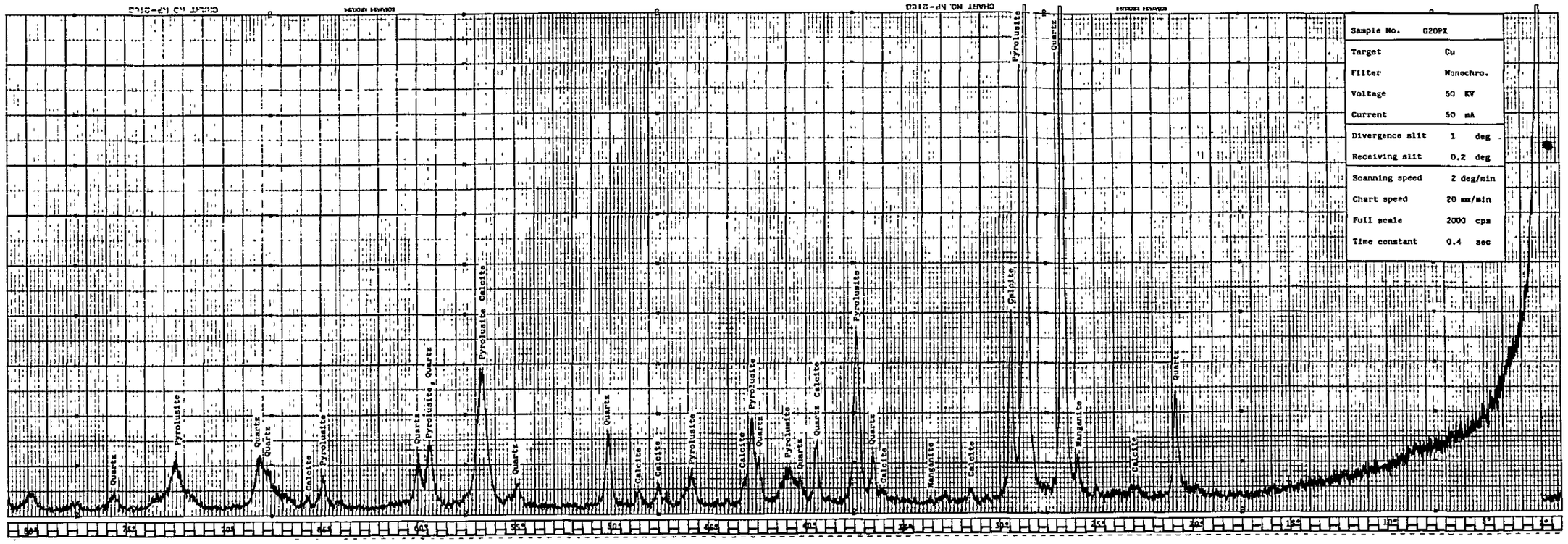
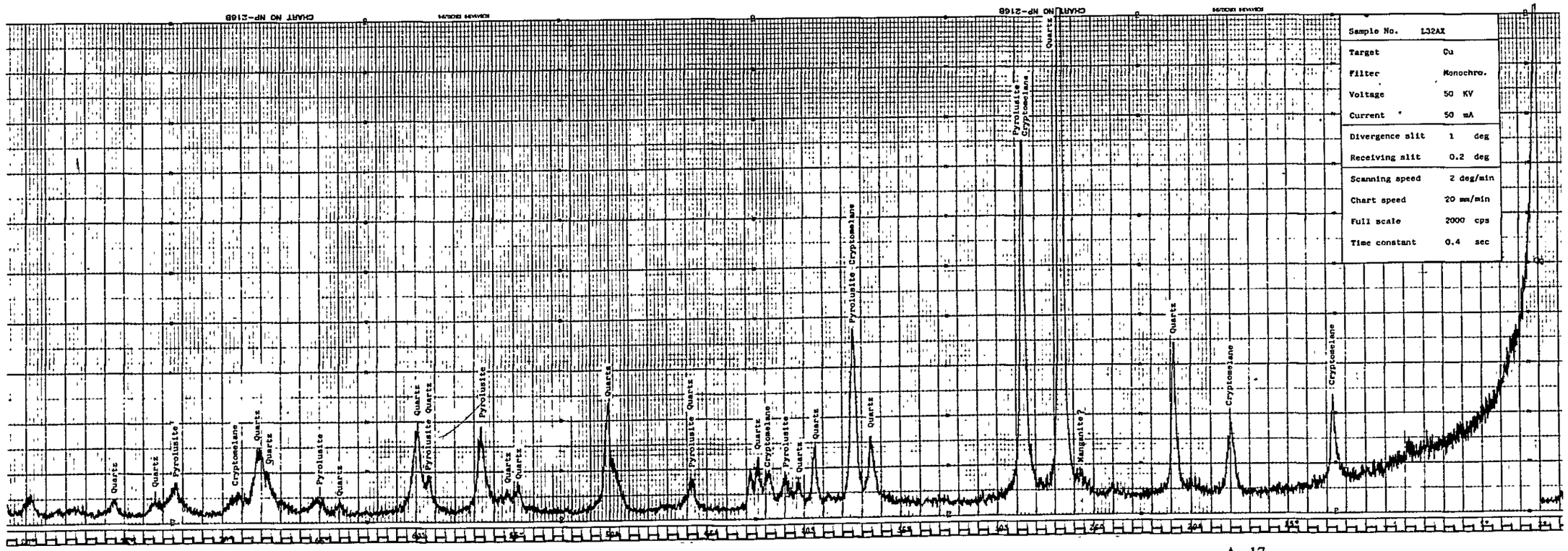
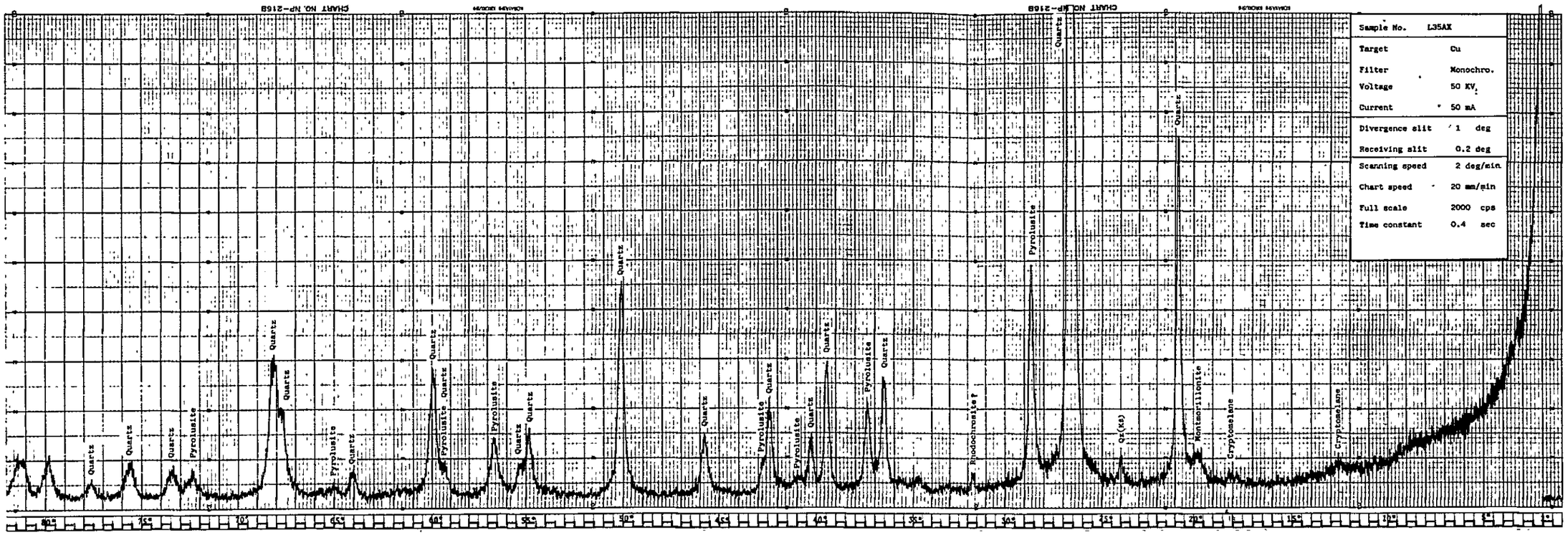

1
2
3
4
5
6
7
8
9
10
11
0.1 mm

Fig. A—4 Chart of X—ray Powder Diffractive Analysis


Sample No. G20PX
Target Cu
Filter Monochro.
Voltage 50 KV
Current 50 mA
Divergence slit 1 deg
Receiving slit 0.2 deg
Scanning speed 2 deg/min
Chart speed 20 mm/min
Full scale 2000 cps
Time constant 0.4 sec
Quartz
Pyrolusite
Calcite
Manganite


Sample No. L32AX
Target Cu
Filter Monochro.
Voltage 50 KV
Current 50 mA
Divergence slit 1 deg
Receiving slit 0.2 deg
Scanning speed 2 deg/min
Chart speed 20 mm/min
Full scale 2000 cps
Time constant 0.4 sec
Quartz
Pyrolusite
Cryptomelane
Manganite ?


Sample No. L35AX
Target Cu
Filter Monochro.
Voltage 50 KV
Current 50 mA
Divergence slit 1 deg
Receiving slit 0.2 deg
Scanning speed 2 deg/min
Chart speed 20 mm/min
Full scale 2000 cps
Time constant 0.4 sec
Quartz
Pyrolusite
Qz(Ks)
Montmorillonite
Cryptomelane
CHART NO. NP-2168

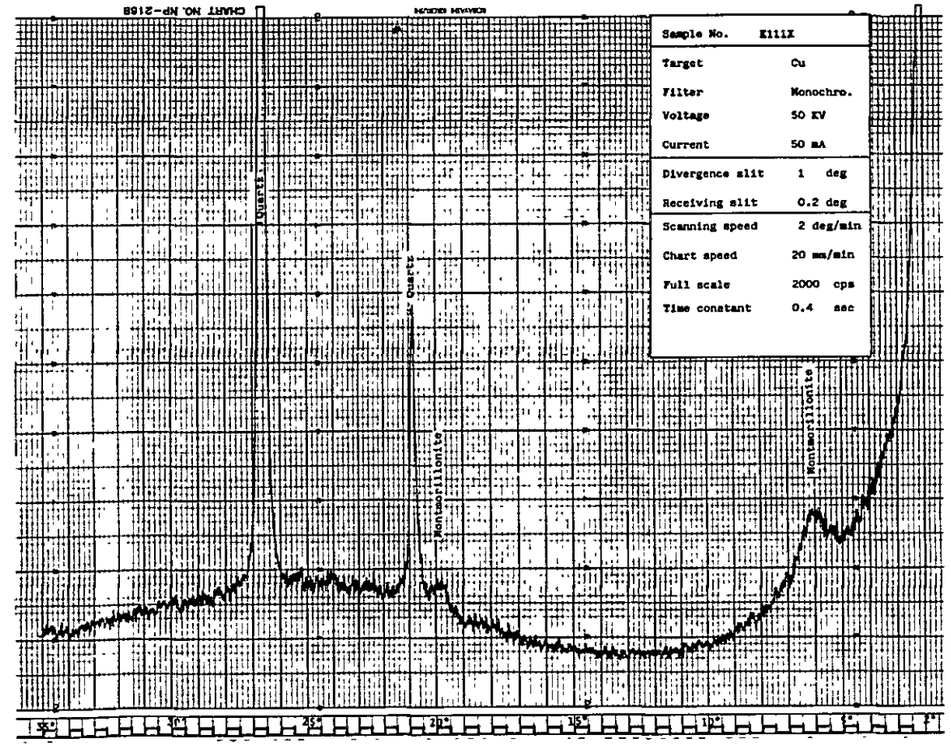

Sample No. K111X
Target Cu
Filter Monochro.
Voltage 50 KV
Current 50 mA
Divergence slit 1 deg
Receiving slit 0.2 deg
Scanning speed 2 deg/min
Chart speed 20 mm/min
Full scale 2000 cps
Time constant 0.4 sec
Quartz
Montmorillonite
CHART NO. NP-2168

Fig. A—5 Geological Log and Assay (1 : 200)

No. 1	(15.50 m)	No. 11	(21.00 m)
No. 2	(18.30 m)	No. 12	(16.50 m)
No. 3	(20.00 m)	No. 13	(15.50 m)
No. 4	(14.00 m)	No. 14	(19.00 m)
No. 5	(14.50 m)	No. 15	(15.00 m)
No. 6	(17.00 m)	No. 16	(19.00 m)
No. 7	(18.00 m)	No. 17	(12.00 m)
No. 8	(21.00 m)		
No. 9	(24.70 m)		
No. 10	(19.00 m)		

- red to reddish brown muddy chert and brown shale
- white to light gray chert and light gray shale
- brown muddy chert and brown shale
- black chert and manganese lens
- manganese ore with brown muddy chert
- manganese ore

ch = chert

No. 1

Depth (m)	Core Log	Assay						Description
		Sample No.	Width (m)	Mn (%)	MnO2 (%)	SiO2 (%)	Fe (%)	
0								0.00 - 3.00 red ch and white ch
								3.00 - 4.50 red ch ≫ black ch
		L-1	0.50	7.65	11.53	73.82	0.67	4.50 - 5.00 manganese ore
5								5.00 - 6.50 brown ch
		L-2	0.50	5.23	8.04	84.71	0.86	6.50 - 10.00 manganese ore black colored
		L-3	0.50	7.55	11.46	80.31	0.67	
		L-4	0.50	9.05	14.08	77.01	0.61	
		L-5	0.50	4.94	7.49	83.17	0.88	
		L-6	0.50	5.27	7.70	85.26	0.63	
		L-7	0.50	9.71	14.77	76.61	0.49	
		L-8	0.50	5.65	8.04	85.94	0.47	
10								10.00 - 11.50 brown ch
								11.50 - 13.50 red ch and white ch
								13.50 - 15.50 red ch and pale brown ch
15 (15.50)								

No. 2

Depth (m)	Core Log	Assay						Description
		Sample No.	Width (m)	Mn (%)	MnO2 (%)	SiO2 (%)	Fe (%)	
0								0.00 - 4.00 reddish purple ch ≫ white ch
								4.00 - 6.00 red ch and white ch
5								6.00 - 8.00 reddish purple ch
								8.00 - 10.00 red ch and white ch
10								10.00 - 11.00 brown ch
		L-9	0.50	2.83	4.78	79.97	1.58	11.00 - 11.50 manganese ore
								11.50 - 13.00 brown ch ≫ black ch
								13.00 - 15.50 red ch and white ch
15								15.50 - 16.00 manganese ore
		L-10	0.50	2.84	4.43	85.25	1.16	16.00 - 18.30 brown ch > red ch and white ch
18.30								

No. 3

Depth (m)	Core Log	Assay						Description
		Sample No.	Width (m)	Mn (%)	MnO2(%)	SiO2(%)	Fe (%)	
0								0.00-2.00 red to purple ch
								2.00-3.00 red ch ≫ white ch
								3.00-4.00 red ch ≫ black ch
								4.00-5.00 purple ch ≫ white ch > black ch
5								5.00-7.00 red to purple ch and white ch
								7.00-8.00 dark purple ch and red ch
								8.00-10.00 brown ch ≫ black ch
10								10.00-11.00 dark brown ch with manganese
								11.00-15.00 purple ch > red ch > white ch
15								15.00-19.00 brown ch > black ch
20.00								19.00-20.00 dark brown ch

No. 4

Depth (m)	Core Log	Assay						Description
		Sample No	Width (m)	Mn (%)	MnO2(%)	SiO2(%)	Fe (%)	
0								0.00-5.00 red ch
5								5.00-6.00 red ch and white ch
								6.00-11.00 white to gray ch
10								11.00-14.00 red ch
14.00								

No. 5

Depth (m)	Core Log	Assay						Description
		Sample No.	Width (m)	Mn (%)	MnO_2 (%)	SiO_2 (%)	Fe (%)	
0								0.00 – 1.00 red ch and white ch 1.00 – 9.00 white ch
5								
10								9.00 – 12.00 white ch and red ch 12.00 – 14.50 purple to red ch and white ch
14.50								

No. 6

Depth (m)	Core Log	Assay						Description
		Sample No.	Width (m)	Mn (%)	MnO_2 (%)	SiO_2 (%)	Fe (%)	
0								0.00 – 1.00 dark purple ch, red ch and white ch 1.00 – 2.00 dark brown ≫ black ch
		L-11	0.50	11.18	16.98	61.74	2.07	
		L-12	0.50	11.55	17.44	60.68	2.07	2.00 – 3.00 manganese ore 3.00 – 4.00 red ch and white ch ≫ black ch 4.00 – 7.00 brown ch > red ch and white ch
5								7.00 – 9.50 brown ch ≫ black ch
10								9.50 – 10.00 red ch 10.00 – 11.00 red ch and white ch 11.00 – 14.00 purple ch, red ch and white ch
15								14.00 – 15.00 white ch 15.00 – 16.00 white ch > red ch 16.00 – 17.00 grayish brown ch
17.00								

No. 7

Depth (m)	Core Log	Assay						Description
		Sample No	Width (m)	Mn (%)	MnO2(%)	SiO2(%)	Fe (%)	
0								0.00 — 1.00 dark purple ch, red ch, white ch 1.00 — 2.00 dark brown ch and red ch
		L 13	1.00	21.04	32.00	49.41	0.88	2.00 — 4.00 manganese ore ≫ red ch
		L 14	1.00	12.86	19.80	65.94	1.21	
5								4.00 — 5.00 red ch ≫ black ch 5.00 — 6.00 brown ch and red ch 6.00 — 8.00 brown ch ≫ black ch
10								8.00 — 11.00 brown ch 11.00 — 12.00 red ch and white ch 12.00 — 13.00 white ch ≫ red ch 13.00 — 16.00 white to gray ch
15								16.00 — 18.00 red ch
18.00								

No. 8

Depth (m)	Core Log	Assay						Description
		Sample No.	Width (m)	Mn (%)	MnO (%)	SiO (%)	Fe (%)	
0								0.00 — 1.00 dark purple ch, red ch, white ch 1.00 — 3.00 dark purple ch ≫ black ch
		L 15	0.50	9.44	15.51	68.18	0.65	3.00 — 3.50 manganese ore 3.50 — 5.00 purple ch and black ch
5								5.00 — 7.50 brown ch ≫ black ch 7.50 — 8.00 pale brown ch
		L 16	0.50	3.04	5.03	83.23	1.45	8.00 — 10.00 manganese ore ≫ brown ch
		L 17	0.50	2.58	4.10	80.19	1.67	
		L 18	1.00	1.74	2.89	81.48	0.65	
10		L 19	0.50	4.75	7.40	75.04	1.62	10.00 — 10.50 manganese ore 10.50 — 13.00 red ch 13.00 — 13.50 red ch > white ch 13.50 — 15.00 white ch > red ch
15								15.00 — 18.00 white to gray ch 18.00 — 19.00 red ch > white ch 19.00 — 20.00 brown to red ch
20								20.00 — 21.00 white ch > red ch
21.00								

No. 9

Depth (m)	Core Log	Sample No.	Width (m)	Mn (%)	MnO2(%)	SiO2(%)	Fe (%)	Description
0								0.00 – 2.00 red ch, white ch > brown ch
								2.00 – 2.50 brown ch ≫ red ch
		L 20	0.50	11 65	17.25	65.60	1 48	
		L 21	0 50	7.79	12.20	71.99	1.58	2.50 – 3.50 manganese ore
5								3.50 – 4.00 brown ch 4.00 – 6.50 red ch 6.50 – 8.00 brown ch ≫ red ch 8.00 – 10.00 brown ch
10		L 22	0.50	4.05	6.59	79.03	1.44	10.00 – 10.50 manganese ore 10.50 – 11.50 manganese ore ≫ brown ch 11.50 – 16.00 brown ch ≫ black ch
15								
		L 23	0 50	9 94	14.98	71.79	0.92	16.00 – 19.00 manganese ore
		L 24	0.50	5.67	9 20	76.31	1.55	
		L 25	0.50	4.08	7.10	75.48	2.01	
		L 26	0.50	8.50	13.22	75.32	1.26	
		L 27	0.50	7 19	10.97	77 33	1.14	
		L 28	0 50	5.66	7.32	82.01	0.74	19.00 – 19.50 manganese ore ≫ brown ch
20		L 29	0 50	4.79	7.54	78 64	1.80	19.50 – 22.00 manganese ore
		L 30	0 50	6 01	8.46	85.25	0 57	
		L 31	0 50	8.79	12 54	77.26	0.83	
		L 32	0.50	21.76	32 22	54.03	0.99	
		L 33	0 50	4.94	7.45	86.93	0.69	
		L 34	1.00	3.11	5.19	82.60	1.49	22.00 – 23.00 manganese ore ≫ brown ch
		L 35	1 00	5.99	9.49	77.94	1.26	23.00 – 24.70 manganese ore
24.70 25		L 36	0.70	10.88	17.88	66.41	1.23	

No. 10

Depth (m)	Core Log	Sample No.	Width (m)	Mn (%)	MnO2(%)	SiO2(%)	Fe (%)	Description
0								0.00 – 2.00 red ch and white ch
								2.00 – 3.00 red ch 3.00 – 3.50 brown ch
		L 37	1.00	10.95	17.88	65.30	1.98	3.50 – 4.00 brown ch ≫ black ch
5		L 38	1 00	8.25	12.28	80.25	0.71	4.00 – 6.00 manganese ore 6.00 – 8.00 brown ch ≫ black ch
								8.00 – 9.00 brown ch ≫ red ch 9.00 – 10.00 red ch
10								10.00 – 11.00 brown ch ≫ black ch 11.00 – 14.00 brown ch
								14.00 – 15.00 brown ch ≫ black ch
15								15.00 – 16.00 brown ch 16.00 – 17.00 brown ch and black ch 17.00 – 19.00 brown ch
19.00								

No. 11

Depth (m)	Core Log	Assay: Sample No.	Width (m)	Mn (%)	MnO2 (%)	SiO2 (%)	Fe (%)	Description
0								0.00 – 2.00 red ch and white ch
								2.00 – 6.00 red ch
5								
								6.00 – 8.50 red ch and brown to orange ch
								8.50 – 9.50 manganese ore ≫ brown ch
10		L 39	1.00	13.52	21.36	63.82	1.43	9.50 – 11.50 manganese ore
		L 40	1.00	22.99	34.05	53.48	0.51	11.50 – 12.50 manganese ore ≫ brown ch
								12.50 – 13.50 pale brown ch ≫ black ch
								13.50 – 18.00 manganese ore ≫ brown ch
15								
								18.00 – 21.00 pale brown ch
20								
21.00								

No. 12

Depth (m)	Core Log	Assay: Sample No.	Width (m)	Mn (%)	MnO2 (%)	SiO2 (%)	Fe (%)	Description
0								0.00 – 1.00 red ch
								1.00 – 3.00 red ch ≫ white ch
								3.00 – 4.00 brown to red ch
								4.00 – 5.00 orange ch
5								5.00 – 7.00 red ch
								7.00 – 9.00 orange to red ch
								9.00 – 11.00 red ch
10								11.00 – 13.00 white ch and red ch
								13.00 – 14.50 red ch
								14.50 – 15.00 red ch ≫ black ch
15								15.00 – 16.00 brown ch ≫ black ch
16.50		L 41	0.50	10.01	16.03	62.46	6.28	16.00 – 16.50 manganese ore ≫ brown ch

No. 13

Depth (m)	Core Log	Assay						Description
		Sample No.	Width (m)	Mn (%)	MnO_2 (%)	SiO_2 (%)	Fe (%)	
0								0.00 – 1.00 purple to red ch and white ch 1.00 – 2.00 red ch 2.00 – 4.00 orange to red ch
								4.00 – 5.00 red ch > white ch 5.00 – 8.00 red to orange ch
5								
								8.00 – 11.00 brown ch and red ch
10								
								11.00 – 12.00 red ch 12.00 – 12.50 red ch and black ch
		L 42	0.50	16.23	26.32	59.27	1.37	
		L 43	0.50	10.08	15.53	66.44	1.95	12.50 – 13.00 manganese ore ≫ brown ch
		L 44	0.50	5.96	9.92	72.46	1.99	
15		L 45	1.00	6.95	11.02	67.08	2.20	13.00 – 13.50 manganese ore
15.50		L 46	0.50	6.47	10.10	70.32	2.30	13.50 – 15.00 manganese ore ≫ brown ch 15.00 – 15.50 manganese ore

No. 14

Depth (m)	Core Log	Assay						Description
		Sample No	Width (m)	Mn (%)	MnO_2 (%)	SiO_2 (%)	Fe (%)	
0								0.00 – 2.50 yellow to orange ch and red ch
								2.50 – 3.00 brown ch ≫ black ch
		L 47	0.50	26.45	41.47	45.60	0.80	3.00 – 3.50 purplish red ch ≫ black ch
5								3.50 – 4.00 manganese ore 4.00 – 5.00 dark brown ch ≫ black ch 5.00 – 6.00 brown ch, red ch ≫ black ch 6.00 – 7.00 grayish brown ch
10								7.00 – 9.00 brown ch > red ch and white ch 9.00 – 11.00 brown to dark brown ch 11.00 – 12.00 brown ch ≫ black ch 12.00 – 13.00 dark brown ch
15								13.00 – 14.00 brown ch, red ch and black ch 14.00 – 15.00 brown ch, red ch and white ch 15.00 – 19.00 brown ch
19.00								

No. 15

Depth (m)	Core Log	Assay						Description
		Sample No.	Width (m)	Mn (%)	MnO_2 (%)	SiO_2 (%)	Fe (%)	
0								0.00 – 2.00 orange to red ch
								2.00 – 6.00 red to brownish red ch > white ch
5								
								600 – 650 red ch 650 – 7.00 brown ch ≫ black ch 7.00 – 900 brown ch, red ch, white ch and black ch
10								300 – 13.00 brown ch
								13.00 – 15.00 reddish brown ch
15.00								

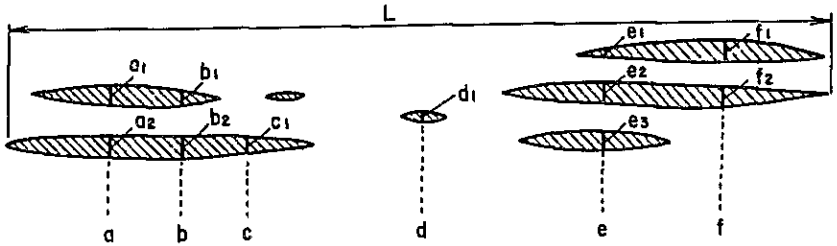
No. 16

Depth (m)	Core Log	Assay						Description
		Sample No	Width (m)	Mn (%)	MnO_2 (%)	SiO_2 (%)	Fe (%)	
0								000 – 1.00 dark brown ch ≫ red ch, white ch 1.00 – 3.00 dark brown to brown ch
								3.00 – 5 00 brown ch > red ch and white ch
5								5.00 – 6 00 brown ch ≫ red ch and white ch > black ch 6.00 – 7.00 brown ch, red ch and white ch 7.00 – 8.00 brown ch > red ch and white ch > black ch
								8.00 – 9.00 brown ch ≫ black ch
10								9.00 – 19.00 brown ch
15								
19 00								

No. 17

Depth (m)	Core Log	Assay						Description
		Sample No	Width (m)	Mn (%)	MnO2 (%)	SiO2 (%)	Fe (%)	
0								0.00 – 1.00 dark brown ch, red ch, white ch 1.00 – 4.00 dark brown ch and black ch 4.00 – 5.00 dark brown ch, red ch, white ch, black ch 5.00 – 10.00 brown ch > black ch > red ch and white ch 10.00 – 12.00 dark brown ch ≫ red ch
5								
10								
12.00								

Schematized Distribution of Manganese Ore Beds



$$\left.\begin{aligned} Ta &= a_1 + a_2 \\ Tb &= b_1 + b_2 \\ Tc &= c_1 \\ Td &= d_1 \\ Te &= e_1 + e_2 + e_3 \\ Tf &= f_1 + f_2 \end{aligned}\right\} \text{thickness of manganese layers in each sampling sites}$$

Ore Reserve = L x F1 x T x F2 x D x S

L : length of strik side

F1 : length factor (0.8)

T : average thickness

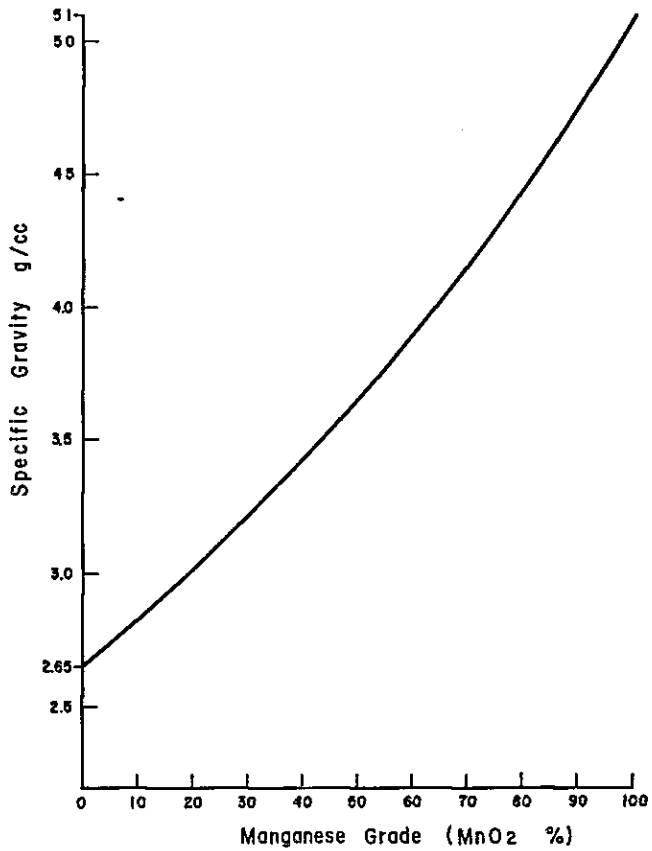
$T = Ta + Tb + Tc + Td + Te + Tf / n$

n : number of sampling site

F2 : shape factor (0.8)

D : length of dip side (30m)

S : specific gravity



Correlation Curve between Manganese Grade (MnO_2) and Specific Gravity

Fig. A—6 Calculation Method of Manganese Ore Reserve

Table A—1 Microscopic Observation of Thin Section

(Sedimentary Rock)

No.	Sample No.	Location			Rock name	Fragments								Matrix										Characteristics
		Area	Co-ordination			Rocks		Minerals															radiolaria fossil	
			Latitude	Longitude		basalt	chert	quartz	potash feldspar	plagioclase	biotite	sericite	opaque minerals	quartz	calcite	sericite	kaoline	carbonate	clay minerals	hematite	limonite	opaque minerals		
15	J083	A	N 24 85.0	E 7 77.5	reddish brown chert									◎	•		•			•		•	◎	laminated
16	J084	A	24 85.0	E 7 77.5	redish brown chert									◎	•				•	•		•	◎	laminated
17	K010	D	24 49.5	7 71.0	limestone	○	?								○							○		
18	K073	D	24 54.5	7 71.0	reddish brown muddy chert									◎			•		•	•			◎	
19	K074	D	24 54.5	7 71.0	reddish brown chert									◎	•	•	•			•		•	◎	laminated
20	K075	D	24 54.5	7 71.0	light grey chert									◎		•	•		•				○	laminated
21	K076	D	24 54.5	7 71.0	light red chert									◎	•	•	•		•				◎	laminated
22	K079	D	24 54.5	7 71.5	light grey chert									◎		○			•					
23	K104	A	24 84.5	7 78.5	light grey chert									◎	○	•						•	○	laminated
24	K106	A	24 84.5	7 78.5	reddish brown chert									◎					•	•		•	◎	laminated
25	K112	A	24 84.5	7 78.5	light brown muddy chert									◎	•				•	•		•	◎	laminated
26	K113	A	24 84.5	7 78.5	reddish brown muddy chert									◎		•	•		•	•			◎	laminated
27	K114	A	24 84.0	7 78.5	white muddy chert									◎	•	•			○				•	lamainted

◎ : abundant ○ : common • : rare

(Sedimentary Rock)

No.	Sample No.	Location			Rock name	Fragments								Matrix										Characteristics
		Area	Co-ordination			Rocks		Minerals																
			Latitude	Longitude		basalt	chert	quartz	potash feldspar	plagioclase	biotite	sericite	opaque minerals	quartz	calcite	sericite	kaoline	carbonate	clay minerals	hematite	limonite	opaque minerals	radiolaria fossil	
1	G027	B	N 24 55.5	E 7 61.5	white chert									◎	•			•					○	laminated
2	G064	B	24 57.5	7 61.0	light grey chert									◎		•		•				•	○	laminated
3	G077	B	24 57.5	7 61.0	red muddy chert									◎	•	•	•	•	•			•	◎	laminated
4	G124	B	24 57.5	7 61.0	yellow chert									◎	•							○	◎	brecciated
5	G125	B	24 57.5	7 61.0	reddish brown muddy chert									◎		•			•			•	◎	laminated
6	G126	B	24 57.5	7 61.0	black chert									◎								○	◎	with Mn mineral
7	H012	D	24 53.5	7 69.5	limestone										◎							•		
8	H032	B	24 58.5	7 61.5	brecciated red chert									◎		•	•					•	◎	
9	H035	B	24 59.5	7 61.0	black chert									◎	•							◎		with Mn mineral
10	J033	C	24 51.0	7 67.0	grey chert									◎					•				○	
11	J040b	B	24 61.0	7 60.0	black chert									◎	◎							◎		with Mn layer
12	J047a	B	24 61.5	7 58.0	limestone									○	◎							•	○	
13	J053	B	24 62.0	7 59.5	yellow chert									◎	◎							◎	◎	brecciated
14	J058	B	24 61.0	7 59.0	light grey chert									◎	•				•				○	

◎ : abundant ○ : common • : rare

(Igneous Rock)

Sample No.	Location		Rock Name	Texture	Minerals																																Remarks
					Phenocryst										Groundmass												Secondary minerals										
	Area	Co-ordination			quartz	potash feldspar	plagoclase	biotite	hornblende	alkali amphibole	augite	hypersthene	olivine	opaque minerals	quartz	potash feldspar	plagoclase	biotite	hornblende	clinopyroxene	orthopyroxene	sphene	apatite	zircon	cassiterite	opaque minerals	chlorite	epidote	sericite	zeolite	quartz	siderite	calcite	kaolin	titanite	prehnite	serpentine	
H014	D	N 2453.5 E 761 0	trachyandesite	trachytic			◎							●													●						●					An40 Ab60
K006	D	2453.5 772.0	dolerite	porphyritic			●	●			◎						◎			○						●		●					●					
K150	B	2455.5 763.5	pyroxenite	equigranular							◎	◎	●																				●				●	

◎ : abundant ○ : common ● : rare

Table A—2 Microscopic Observation of Polished Section

No.	Sample No.	Area	Co-ordinates		Type of Ore	Texture	Ore Mineral				Fossil	Remarks
			Latitude	Longitude			Pyrl	man	crpt	hem		
1	G015	B	N 2458.0	E 760.5	banded		•					
2	G020	B	2456.5	761.0	network		◎	?			◎	secondary segregation vein
3	G058	B	2457.5	760.5	nodular	banded,	◎					
4	G063	B	2457.5	761.0	massive		◎					
5	G109	B	2457.5	761.0	massive		◎					
6	G110	B	2457.5	761.0	banded		◎					
7	H048	B	2462.5	759.5	massive		◎	?				
8	J037	D	2452.5	771.5	veinlet		◎					secondary segregation vein
9	K018	B	2458.0	758.5	fine-banded, brecciated	colloform-banded	◎		?			
10	K060	D	2455.0	771.0	nodular		◎					
11	K069	D	2455.0	771.0	nodular		◎	?	?		◎	secondary segregation vein
12	K092	B	2457.5	761.0	massive		◎					
13	K100	A	2484.5	778.5	massive	colloform	◎	?				
14	K102	A	2484.5	778.5	brecciated		◎					secondary segregation vein
15	K108	A	2484.5	778.5	massive		◎					
16	L032	A	Drilling No.9		massive ?		◎		•			drilling cutting

◎ ; abundant, ○ ; common, • ; rare, ? ; uncertain

Abbreviations

pyrl : pyrolusite man : manganite crpt : cryptomelane hem : hematite

Table A—3 List of Fossil (Radiolaria)

Species of Foraminifera \ Sample No.	H003F	H017F	H037F	K012F	K013F	K070F	K071F	K075F	K076F	K077F	K078F	K079F	K081F	K082F	K093F	K103F	K104F	K105F	K106F	K107F
Area	D	D	B	C	C	D	D	D	D	D	D	D	D	D	B	A	A	A	A	A
Member	Hmw	Hls	Hls	Hms	Hmr	Hmr	Hmr	Hls	Hls	Hmr	Hmw	Hls	Hmw	Hmr	Hmr	Hmw	Hmw	Hmr	Hmr	Hmr
Estimated age	Early Creta. (Valanginian ~ Barremian)	Not estimated (Radiolaria not detected)	Late Jura ~ Early Creta. (Tithonian) (Berriacian)	Late Jura. ~ Early Creta. (Tithonian) (Berriacian)	Early Creta. (Valanginian ~ Barremian)	Not estimated (Radiorlia not detected)	Early Creta. (Valanginian ~ Barremian)	Early Creta. (Stage not specified)	Late Jura. ~ Early Creta. (Tithonian) (Hauterivian)	Early Creta. (Valanginian ~ Berriacian)	Early Creta. (Barremian ~ Aptian)	Not estimated (Radiolaria not detected)	Early Creta. (Valanginian ~ Barremian)	Early Creta. (Valanginian ~ Barremian)	Early Creta. (Barremian ~ Aptian)	Early Creta. (Valanginian ~ Barremian)	Early Creta. (Barremian ~ Aptian)	Not estimated (Radiolaria not detected)	Early Creta. (Valanginian ~ Berriasian)	Early Creta. (? ~ Barremian?)
Acaenlotile diaphorogona Foreman														○						
A. sp.															○					
Acanthocircus dicranocanthos (Squinabol)																○			○	
Alievium helenae Schaaf	○												○		○		○			
A. sp.							○				○			○		○			○	
Archaeodictyomitra apiara (Rüst)	○		○	○				○			○					○			○	○
A. aff. *apiara* (Rüst)									○											
A. *lacrimula* (Foreman)													○	○	○		○			
A. *pseudoscalaris* (Tan Sin Hok)															○		○			
Archaeospongoprimum cf. *imlayi* Pessango								○												
A. cf. *tehamaensis* Pessango					○															
A. spp							○													
Ceclops septemporatus (Parona)																	○			
C. sp.													○		○					
Crucella sp.				○																
Dictyomitra(?) sp.							○		○											
Emilvia sp. cf. *purisimaensis* Pessango					○															
E. sp.	○							○												
Eucyrtidum (?) *ptyctum* Riedel and Sanfillipo			○	○					○										○	
E. sp.			○											○						
Eucyrtis micropora (Squinabol)															○		○			
E. *tenuis* (Rüst)													○		○		○			
E. sp.											○									
Hemicryptocapsa cf. *capita* Tan									○											
H. sp.	○												○							
H. spp																○				
Holocryptocanium sp.											○									
H. spp.															○	○	○			
Hsuum (?) sp.																				○
Mirifusus baileyi Pessango					○															
M. sp.									○						○	○				
M. (?) sp.																				○
Napora sp.			○		○															
Obesacapsula sp. cf. *Morroensis* Pessango					○															
Pantanellium sp.	○				○											○				
P. spp.							○							○	○		○		○	
Parvicingula boessi (Parona)	○			○	○				○					○	○	○			○	
P. sp. cf. *boessi* (Parona)							○													
P. sp.			○	○	○				○						○		○		○	○
Paronaella sp.			○	○				○												
Patulibracchium sp.							○		○											
Podobursa sp.	○						○	○	○				○		○					○
P. spp.				○	○															
Podocapsa (?) sp.					○															
Protunuma sp.			○						○											
Pseudodictyomitra carpatica (Lazyniak)	○			○							○			○		○			○	
P. aff. *minoensis* Mizutani			○	○	○															
P. cf. *pseudomacrocephara*															○					
P. sp.	○				○								○	○	○					○
Saitoum sp.			○	○	○															
Sethocapsa leiostraca Foreman													○	○						
S. *trachyostraca* Foreman					○								○	○			○			
S. cf. *trachyostraca* (Foreman)															○					
S. *uterculus* (Parona)	○						○													
S. sp.				○					○		○		○							○
S. (?) sp.			○								○									
Spongosatunatis (?) sp.							○													
Staurosphaera septempotata Foreman							○													
S. *septemporatus* (Parona)	○																			
Stichomitra sp.									○											
S. (?) sp.													○							
Thanarla conica (Aliev)	○			○					○					○	○				○	
T. aff. *conica* (Alive)																○				
T. *pulchra* (Squinabol)	○						○				○		○	○	○	○				
Tnactoma cellulosa Foreman							○		○											
T. *hybum* Foreman														○						
Tricolocapsa sp.			○																○	
Ultranapora sp.							○										○			
Xitus sp.	○																○		○	

Table A—4 Result of X—ray Powder Diffractive Analysis

No.	Sample No.	Area	Rock name	Minerals							Indetermined small peak
				pyrl	man	crpt	rhc	qz	cal	mn	
1	G15PX	B	manganese ore	•				◎	○		
2	G20PX	"	" (network)	◎	•			◎	○		3.56Å, 2.72Å
3	G58PX	"	" (nodular)	◎	?			○			7.6Å
4	G109PX	"	"	◎	?			•			
5	G110PX	"	"	◎				◎			
6	H48PX	"	"	◎	•			○			
7	J37PX	D	" (veinlet)	◎				◎			2.03Å
8	K18PTX	B	"	◎		•		○			
9	K69PTX	D	" (nodular)	◎	•	•		•	○		
10	K92APX	B	"	◎	?			•	○		
11	K100PX	A	"	◎	•	?		?			
12	K102PX	"	" (veinlet)	○				◎			
13	L26	"	"	◎	?	•		○		•	
14	L32	"	"	○	?	○		◎			
15	L35	"	"	○		•	?	◎		•	2.58Å
16	G34TX	"	light pink muddy chert					◎	•	•	
17	K111X	"	light brown muddy chert					◎	•	•	

Abbreviations : pyrl ; pyrolusite, man ; manganite, crpt ; cryptomelane, rdc ; rhodochrosite, qz; quartz, cal; calcite, mn; montmorillonite.

◎ ; abundant, ○ ; common, • ; rare, ? ; uncertain.

Table A—5 Result of Chemical Analysis of Manganese Ore in Geological Survey

No.	Sample No.	Location			Type of Ore	Sampling Width (cm)	Content of Elements			
		Area	Outcrop No.	Co-ordination			Mn(%)	MnO_2(%)	SiO_2(%)	Fe(%)
1	G009	B	178	N–2458.0 E– 760.5	nodular	70	10.44	17.48	75.94	0.61
2	G014	B	177	N–2458.0 E– 760.5	layered	15	20.06	31.72	60.95	0.56
3	G026	B	186	N–2456.5 E– 762.0	do	30	13.29	23.49	70.96	0.31
4	G028	B	187	N–2455.5 E– 761.5	do	10	39.61	62.71	28.86	0.11
5	G029	B	187	N–2455.5 E– 761.5	do	30	24.63	39.82	52.32	0.16
6	G043	B	179	N–2458.0 E– 760.5	do	5	18.34	28.95	63.05	0.27
7	G045	B	159	N–2458.0 E– 760.5	layered nodular	80	8.97	14.66	74.11	0.60
8	G046	B	159	N–2458.0 E– 760.5	do	40	6.76	10.75	70.85	1.16
9	G047	B	159	N–2458.0 E– 760.5	nodular	50	10.24	16.59	66.68	1.00
10	G048	B	159	N–2458.0 E– 760.5	do	30	13.32	21.38	62.78	1.04
11	G053	B	159	N–2458.0 E– 760.5	do	50	18.39	29.48	62.39	0.53
12	G054	B	159	N–2458.0 E– 760.5	layered	50	11.90	20.18	73.21	0.63
13	G055	B	159	N–2458.0 E– 760.5	do	25	7.07	12.98	80.54	0.79
14	G056	B	159	N–2458.0 E– 760.5	do	75	15.25	26.41	66.39	0.63
15	G057	B	159	N–2458.0 G– 760.5	do	40	8.67	14.38	78.69	0.68
16	G058	B	159	N–2457.5 E– 760.5	layered nodular	120	11.50	20.79	68.72	0.66
17	G059	B	159	N–2457.5 E– 760.5	do	30	20.57	32.24	46.45	1.46
18	G060	B	159	N–2457.5 E– 760.5	nodular~ layered	25	15.94	25.20	67.36	0.25
19	G061	B	159	N–2457.5 E– 760.5	layered~ nodular	110	29.35	46.20	46.25	0.20
20	G062	B	159	N–2457.5 E– 760.5	do	190	17.57	28.45	60.46	0.27
21	G063	B	180	N–2457.5 E– 761.0	layered	20	52.97	85.14	4.73	0.07
22	G065	B	159	N–2457.5 E– 761.0	layered ~nodular	300	20.43	32.88	56.88	0.25
23	G066	B	159	N–2457.5 E– 761.0	layered	40	37.43	59.52	31.12	0.11
24	G067	B	159	N–2457.5 E– 761.0	do	60	20.97	33.64	53.75	0.24
25	G075	B	159	N–2457.5 E– 761.0	layered ~nodular	200	13.59	22.00	47.15	0.74
26	G076	B	159	N–2457.5 E– 761.0	do	100	24.18	37.53	35.15	0.45
27	G078	B	159	N–2457.5 E– 761.0	layered	25	17.17	26.85	65.74	0.22
28	G080	B	159	N–2457.5 E– 761.0	do	130	21.81	34.47	56.05	0.22
29	G081	B	159	N–2457.5 E– 761.0	nodular	50	17.45	29.01	63.09	0.41
30	G083	B	159	N–2457.5 E– 761.0	do	30	21.21	35.46	59.67	0.52

No.	Sample No.	Area	Location Outcrop No.	Co-ordination	Type of Ore	Sampling Width (cm)	Content of Elements			
							Mn(%)	MnO_2(%)	SiO_2(%)	Fe(%)
31	G085	B	159	N–2457.5 E– 761.0	layered	90	28.32	44.11	45.35	0.20
32	G086	B	159	N–2457.5 E– 761.0	do	30	26.77	44.70	40.45	0.34
33	G087	B	159	N–2457.5 E– 761.0	do	50	18.02	31.43	61.44	0.31
34	G088	B	159	N–2457.5 E– 761.0	do	25	39.40	62.85	30.19	0.10
35	G089	B	159	N–2457.5 E– 761.0	do	50	27.00	44.22	43.34	0.20
36	G090	B	159	N–2457.5 E– 761.0	do	20	16.58	26.39	67.15	0.19
37	G091	B	159	N–2457.5 E– 761.0	do	25	5.10	8.68	84.82	0.81
38	G092	B	159	N–2457.5 E– 761.0	do	100	32.28	52.55	37.56	0.11
39	G093	B	159	N–2457.5 E– 761.0	do	40	17.34	28.14	67.89	0.25
40	G094	B	159	N–2457.5 E– 761.0	do	25	26.48	42.15	47.54	0.20
41	G095	B	159	N–2457.5 E– 761.0	do	100	22.28	36.02	49.03	0.22
42	G096	B	159	N–2457.5 E– 761.0	layered ~nodular	70	21.33	35.38	54.90	0.56
43	G097	B	159	N–2457.5 E– 761.0	do	110	18.53	31.47	61.92	0.58
44	G098	B	159	N–2457.5 E– 761.0	do	50	28.46	46.92	42.41	0.37
45	G099	B	159	N–2457.5 E– 761.0	layered	30	32.59	50.87	39.57	0.19
46	G100	B	159	N–2457.5 E– 761.0	do	100	20.91	34.90	61.19	0.17
47	G101	B	159	N–2457.5 E– 761.0	do	30	27.13	44.52	48.01	0.10
48	G102	B	159	N–2457.5 E– 761.0	do	80	41.69	68.10	23.74	0.06
49	G103	B	159	N–2457.5 E– 761.0	nodular	100	20.26	36.47	55.12	0.30
50	G104	B	159	N–2457.5 E– 761.0	layered	50	23.06	37.44	54.43	0.19
51	G105	B	159	N–2457.5 E– 761.0	do	30	24.36	40.06	56.40	0.17
52	G106	B	159	N–2457.5 E– 761.0	do	30	28.37	46.80	47.22	0.33
53	G108	B	159	N–2457.5 E– 761.0	do	240	14.63	23.71	72.20	0.17
54	G109	B	159	N–2457.5 E– 761.0	do	200	25.61	40.46	52.36	0.15
55	G110	B	159	N–2457.5 E– 761.0	do	250	33.05	52.34	36.66	0.13
56	G111	B	159	N–2457.5 E– 761.0	do	120	32.21	53.41	31.54	0.17
57	G112	B	159	N–2457.5 E– 761.0	nodular~ layered	100	15.64	30.44	27.55	0.65
58	G113	B	159	N–2457.5 E– 761.0	layered	20	21.65	34.46	52.28	0.27
59	G114	B	159	N–2457.5 E– 761.0	do	35	20.76	33.36	54.23	0.20
60	G115	B	159	N–2457.5 E– 761.0	do	30	24.25	41.89	42.78	0.48

No.	Sample No.	Area	Location Outcrop No.	Co-ordination	Type of Ore	Sampling Width (cm)	Content of Elements			
							Mn(%)	MnO_2(%)	SiO_2(%)	Fe(%)
61	G116	B	184	N–2457.0 E– 761.0	layered ~nodular	250	13.63	25.09	70.23	0.47
62	G117	B	184	N–2457.0 E– 761.0	layered	70	14.30	23.23	66.89	0.41
63	G119	B	184	N–2456.5 E– 761.0	layered ~nodular	80	18.62	33.75	52.94	0.52
64	G121	B	184	N–2456.5 E– 761.5	do	100	14.54	26.94	67.72	0.51
65	G122	B	184	N–2456.0 E– 761.5	do	100	19.43	37.18	62.85	0.38
66	G123	B	184	N–2456.0 E– 761.5	do	60	14.02	23.23	66.25	0.40
67	H011	D	194	N–2453.5 E– 769.0	layered	30	12.60	20.35	69.65	0.30
68	H023	C	188	N–2452.5 E– 766.5	do	25	22.26	34.75	52.87	0.38
69	H028	C	188	N–2452.5 E– 766.5	do	50	33.40	52.43	38.14	0.25
70	H029	C	190	N–2452.0 E– 766.5	do	40	29.68	47.07	44.13	0.20
71	H033	B	173	N–2459.5 E– 761.5	do	80	21.20	34.07	56.37	0.19
72	H038	B	172	N–2459.5 E– 760.5	do	60	38.01	61.36	30.26	0.11
73	H039	B	172	N–2459.5 E– 760.5	do	30	11.01	18.75	73.28	0.23
74	H040	B	171	N–2460.0 E– 760.5	do	25	29.24	46.99	45.75	0.16
75	H041	B	158	N–2460.0 E– 760.5	do	300	20.50	29.88	54.92	0.20
76	H043	B	158	N–2460.5 E– 760.5	do	350	29.81	47.49	45.24	0.23
77	H044	B	158	N–2460.5 E– 760.5	do	60	28.11	44.31	47.47	0.37
78	H045	B	155	N–2463.0 E– 759.5	do	65	25.92	41.11	49.85	1.08
79	H046	B	168	N–2463.0 E– 759.5	do	60	21.85	34.56	56.78	0.27
80	H047	B	170	N–2462.5 E– 759.5	do	70	40.08	65.94	27.21	0.16
81	H049	B	169	N–2462.5 E– 759.5	do	130	25.61	41.47	51.52	0.28
82	H062	A	93	N–2484.0 E– 779.0	do	20	33.20	51.94	40.95	0.16
83	H064	A	94	N–2483.5 E– 779.0	do	35	16.69	27.58	67.87	0.26
84	H070	A	69	N–2481.5 E– 780.5	do	10	20.82	34.00	61.25	0.19
85	H071	A	69	N–2481.5 E– 780.5	do	10	10.27	17.24	79.44	0.36
86	H072	A	69	N–2481.5 E– 780.0	do	17	20.28	32.99	61.10	0.25
87	H073	A	69	N–2481.5 E– 780.0	do	15	12.56	21.15	75.62	0.29
88	H074	A	69	N–2481.5 E– 780.0	do	55	13.48	22.34	71.00	0.27
89	H075	A	69	N–2481.5 E– 780.0	do	25	32.77	52.74	40.84	0.19
90	H076	A	69	N–2481.5 E– 780.0	do	12	8.15	13.57	82.94	0.33

No.	Sample No.	Area	Location Outcrop No.	Co-ordination	Type of Ore	Sampling Width (cm)	Content of Elements			
							Mn(%)	MnO_2(%)	SiO_2(%)	Fe(%)
91	H077	A	69	N-2481.5 E- 780.0	layered	50	9.96	17.42	77.69	0.30
92	H078	A	69	N-2481.5 E- 780.0	do	50	8.11	12.15	83.13	0.30
93	H079	A	69	N-2481.5 E- 780.0	do	40	18.39	27.75	64.48	0.18
94	H081	A	71	N-2481.5 E- 780.0	do	60	18.51	30.22	65.93	0.25
95	H082	A	71	N-2481.0 E- 780.0	do	40	21.56	34.73	59.32	0.22
96	H083	A	71	N-2481.0 E- 780.0	do	315	14.80	23.24	67.03	0.53
97	H084	A	71	N-2481.0 E- 779.5	do	190	14.72	23.57	68.26	0.57
98	H085	A	110	N-2484.0 E- 778.5	do	70	34.98	55.38	37.16	0.11
99	H086	A	110	N-2484.5 E- 778.5	do	30	28.31	44.36	48.47	0.17
100	H087	A	110	N-2484.5 E- 778.5	do	30	16.57	26.27	70.19	0.23
101	H088	A	110	N-2484.5 E- 778.5	do	50	24.84	39.51	53.55	0.26
102	H089	A	110	N-2484.5 E- 778.5	do	50	30.07	46.82	26.40	0.16
103	H090	A	110	N-2484.5 E- 778.5	do	100	21.19	33.79	61.38	0.19
104	H091	A	110	N-2484.5 E- 778.5	do	35	19.06	29.90	63.19	0.32
105	H092	A	110	N-2484.5 E- 778.5	do	30	41.29	65.85	27.07	0.01
106	H093	A	110	N-2484.5 E- 778.5	do	120	13.42	21.17	73.28	0.27
107	H094	A	110	N-2484.5 E- 778.5	do	30	34.88	56.20	36.65	0.13
108	H095	A	110	N-2484.5 E- 778.5	do	70	17.86	28.38	64.66	0.29
109	H096	A	110	N-2484.5 E- 778.5	do	50	17.56	27.51	67.61	0.32
110	H097	A	110	N-2484.5 E- 778.5	do	190	15.79	25.77	67.65	0.38
111	H098	A	110	N-2484.5 E- 778.5	do	20	20.04	32.30	61.14	0.30
112	H099	A	110	N-2484.5 E- 778.5	do	55	18.94	30.93	64.54	0.22
113	H100	A	110	N-2484.5 E- 778.5	do	20	15.17	23.73	69.75	0.26
114	H101	A	110	N-2484.5 E- 778.5	do	23	8.38	13.34	81.78	0.28
115	H102	A	110	N-2484.5 E- 778.5	do	27	12.77	19.33	72.96	0.30
116	H103	A	110	N-2484.5 E- 778.5	do	20	15.90	24.13	68.74	0.25
117	H104	A	110	N-2484.5 E- 778.5	do	30	24.88	39.40	51.04	0.22
118	H105	A	110	N-2484.5 E- 778.5	do	70	13.24	21.05	70.64	0.34
119	H106	A	110	N-2484.5 E- 778.5	do	60	9.67	15.09	79.25	0.32
120	H107	A	110	N-2484.5 E- 778.5	do	55	21.55	33.64	58.12	0.25

No.	Sample No.	Area	Location Outcrop No.	Co-ordination	Type of Ore	Sampling Width (cm)	Content of Elements			
							Mn(%)	MnO_2(%)	SiO_2(%)	Fe(%)
121	H108	A	110	N-2484.5 E- 778.5	Layered	18	15.47	25.86	60.01	0.30
122	H109	A	110	N-2484.5 E- 778.5	do	60	13.69	21.87	70.48	0.32
123	H110	A	110	N-2484.5 E- 778.5	do	15	8.14	12.93	83.37	0.27
124	H111	A	110	N-2484.5 E- 778.5	do	75	14.66	23.35	70.61	0.27
125	H112	A	110	N-2484.5 E- 778.5	do	27	12.87	19.82	75.53	0.33
126	H113	A	110	N-2484.5 E- 778.5	do	26	12.62	19.57	75.65	0.27
127	H114	A	110	N-2484.5 E- 778.5	do	13	15.75	24.46	70.54	0.29
128	H116	A	110	N-2484.5 E- 778.0	do	17	13.90	21.88	72.00	0.45
129	H118	A	110	N-2484.5 E- 778.0	do	13	11.85	18.45	74.01	0.79
130	H119	A	110	N-2484.5 E- 778.0	do	20	15.36	25.03	71.29	0.34
131	H121	A	110	N-2484.5 E- 778.0	do	8	12.87	22.07	72.14	0.44
132	H122	A	110	N-2484.5 E- 778.0	do	22	14.05	23.51	71.16	0.55
133	H123	A	110	N-2484.5 E- 778.0	do	59	8.39	14.42	80.49	0.67
134	H126	A	110	N-2484.5 E- 778.0	do	13	6.16	10.83	86.44	0.48
135	H127	A	110	N-2484.5 E- 778.0	do	19	12.39	20.46	76.34	0.32
136	H128	A	110	N-2485.0 E- 778.0	do	54	26.77	42.77	49.64	0.24
137	H129	A	110	N-2485.0 E- 778.0	do	11	8.16	12.39	83.58	0.31
138	H131	A	110	N-2485.0 E- 778.0	do	9	21.57	34.42	49.73	0.25
139	H132	A	110	N-2485.0 E- 778.0	do	12	17.32	27.43	67.04	0.45
140	H133	A	110	N-2485.0 E- 777.5	do	28	18.34	30.18	65.83	0.27
141	H135	A	110	N-2485.0 E- 777.5	do	28	12.32	19.22	70.39	3.00
142	H136	A	110	N-2485.0 E- 777.5	do	17	19.70	30.61	63.64	0.27
143	H137	A	110	N-2485.0 E- 777.5	do	17	11.77	18.51	78.79	0.31
144	H138	A	110	N-2485.0 E- 777.5	do	14	21.77	32.72	60.20	0.32
145	H139	A	110	N-2485.0 E- 777.5	do	24	16.09	24.90	69.69	0.29
146	H140	A	110	N-2485.0 E- 777.5	do	52	20.06	31.98	61.70	0.23
147	H141	A	110	N-2484.5 E- 778.5	do	30	18.13	28.69	64.35	0.22
148	H142	A	110	N-2484.5 E- 778.5	do	135	28.81	44.98	47.85	0.19
149	H143	A	110	N-2484.0 E- 778.5	do	95	23.89	38.18	54.24	0.26
150	J024	C	161	N-2452.0 E- 767.0	do	160	9.27	14.98	78.91	1.61

No.	Sample No.	Area	Location Outcrop No.	Co-ordination	Type of Ore	Sampling Width (cm)	Content of Elements			
							Mn(%)	MnO_2(%)	SiO_2(%)	Fe(%)
151	J025	C	161	N–2452.0 E– 767.0	Layered	110	7.90	12.34	81.88	0.43
152	J073	A	140	N–2483.5 E– 776.0	do	51	8.30	13.88	82.96	0.29
153	J074	A	140	N–2483.5 E– 776.5	do	60	20.61	32.86	62.03	0.19
154	J075	A	140	N–2483.5 E– 776.5	do	49	19.75	31.96	62.61	0.25
155	J087	A	136	N–2484.5 E– 776.5	do	38	17.94	28.10	66.97	0.27
156	J088	A	136	N–2484.5 E– 776.5	do	38	15.17	24.35	70.92	0.38
157	J089	A	136	N–2484.5 E– 776.5	do	37	18.16	28.98	65.36	0.29
158	J090	A	136	N–2484.5 E– 776.5	do	45	16.76	25.97	68.96	0.33
159	J091	A	136	N–2484.5 E– 776.5	do	36	12.55	20.13	73.46	0.52
160	J092	A	136	N–2484.5 E– 776.5	do	45	25.22	39.60	53.77	0.15
161	J093	A	136	N–2484.5 E– 776.5	do	56	21.43	34.35	59.13	0.55
162	J094	A	136	N–2484.5 E– 776.5	do	23	12.97	20.25	74.16	0.33
163	J095	A	136	N–2484.5 E– 776.5	do	41	15.21	23.42	69.86	0.30
164	J096	A	136	N–2484.5 E– 776.5	do	20	24.60	38.74	54.58	0.30
165	J097	A	136	N–2484.5 E– 776.5	do	38	13.40	21.42	72.90	0.30
166	J098	A	136	N–2484.5 E– 776.5	do	31	7.64	12.40	84.13	0.32
167	J099	A	136	N–2484.5 E– 776.5	do	25	29.50	46.23	48.74	0.21
168	J100	A	136	N–2484.5 E– 776.5	do	42	20.31	31.97	60.17	0.32
169	J101	A	136	N–2484.5 E– 776.5	do	62	12.98	20.35	72.97	0.29
170	J102	A	136	N–2484.5 E– 776.5	do	73	17.40	28.11	67.44	0.22
171	J103	A	136	N–2484.5 E– 776.5	do	35	18.08	29.08	65.50	0.39
172	J104	A	136	N–2484.5 E– 776.5	do	82	16.26	25.95	69.82	0.32
173	J105	A	136	N–2484.5 E– 776.5	do	70	14.37	22.85	72.98	0.22
174	J106	A	136	N–2484.5 E– 776.5	do	35	11.22	18.19	78.96	0.30
175	J107	A	136	N–2484.5 E– 776.5	do	41	18.64	29.27	65.75	0.33
176	K004	D	160	N–2454.5 E– 771.0	do	60	18.19	29.28	66.76	0.30
177	K016	B	185	N–2456.5 E– 763.0	do	60	22.77	36.86	56.66	0.31
178	K017	B	185	N–2456.5 E– 763.0	do	30	21.13	35.53	59.34	0.31
179	K019	B	174	N–2458.0 E– 758.5	do	70	44.37	71.29	19.56	0.04
180	K020	B	175	N–2458.0 E– 758.5	do	20	14.71	24.74	71.51	0.33

No.	Sample No.	Area	Location Outcrop No.	Co-ordination	Type of Ore	Sampling Width (cm)	Content of Elements			
							Mn(%)	MnO_2(%)	SiO_2(%)	Fe(%)
181	K022	B	176	N-2458.0 E- 758.5	layered	30	28.55	45.14	45.00	0.24
182	K024	B	181	N-2457.5 E- 759.0	do	40	22.48	35.44	55.76	0.20
183	K026a	B	183	N-2457.0 E- 759.0	do	31	36.10	56.89	33.76	0.44
184	K026b	B	183	N-2457.0 E- 759.0	do	39	10.87	17.49	73.94	0.41
185	K027	B	182	N-2457.5 E- 758.5	do	28	44.61	71.49	19.02	0.07
186	K050	D	160	N-2454.5 E- 771.0	do	25	30.22	48.82	41.96	0.16
187	K051	D	160	N-2454.5 E- 771.0	do	25	12.77	20.15	72.80	0.37
188	K052	D	160	N-2454.5 E- 771.0	do	50	15.55	24.73	69.46	0.27
189	K053a	D	160	N-2455.0 E- 771.0	do	33	30.11	48.30	45.02	0.18
190	K053b	D	160	N-2455.0 E- 771.0	do	35	14.02	22.90	70.46	0.28
191	K054	D	160	N-2455.0 E- 771.0	do	140	18.92	30.89	64.51	0.25
192	K055a	D	160	N-2455.0 E- 771.0	do	70	16.68	26.38	69.17	0.25
193	K055b	D	160	N-2455.0 E- 771.0	do	60	31.56	49.96	43.27	0.16
194	K055c	D	160	N-2455.0 E- 771.0	do	270	28.17	45.59	43.55	0.18
195	K056	D	192	N-2454.5 E- 771.0	do	17	29.00	46.22	46.55	0.16
196	K057a	D	192	N-2455.0 E- 771.0	do	25	36.75	59.63	34.11	0.13
197	K057b	D	192	N-2455.0 E- 771.0	do	30	19.48	30.86	57.87	0.27
198	K058a	D	192	N-2455.0 E- 771.0	do	80	25.73	42.63	45.88	0.14
199	K058b	D	192	N-2455.0 E- 771.0	do	20	23.36	37.89	47.99	0.21
200	K059	D	192	N-2455.0 E- 771.0	do	29	39.39	64.05	26.22	0.90
201	K060	D	160	N-2455.0 E- 771.0	do	150	32.24	51.75	36.27	0.15
202	K061	D	160	N-2455.0 E- 771.0	do	110	40.62	61.12	31.90	0.15
203	K062	D	160	N-2455.0 E- 771.0	do	20	15.45	25.45	67.01	0.34
204	K063	D	160	N-2455.0 E- 771.0	do	40	19.03	30.55	58.31	0.34
205	K064	D	160	N-2455.0 E- 771.0	do	15	6.83	11.02	82.26	0.51
206	K090	B	159	N-2457.5 E- 761.0	do	300	23.99	37.93	46.20	1.14
207	K091	B	159	N-2457.5 E- 761.0	do	170	16.06	26.06	59.40	0.41

Table A—6 Result of Chemical Analysis of Manganese Ore in Drilling Survey

No.	Sample No.	Hole No.	Depth	Sampling Width (cm)	Content of Elements			
					Mn(%)	MnO_2(%)	SiO_2(%)	Fe(%)
1	L01	No.1	4.50m ~ 5.00m	0.50	7.65	11.53	73.82	0.67
2	L02		6.50 ~ 7.00	0.50	5.23	8.04	84.71	0.86
3	L03		7.00 ~ 7.50	0.50	7.55	11.46	80.31	0.67
4	L04		7.50 ~ 8.00	0.50	9.05	14.08	77.01	0.61
5	L05		8.00 ~ 8.50	0.50	4.94	7.49	83.17	0.88
6	L06		8.50 ~ 9.00	0.50	5.27	7.70	85.26	0.63
7	L07		9.00 ~ 9.50	0.50	9.71	14.77	76.61	0.49
8	L08		9.50 ~10.00	0.50	5.65	8.04	85.94	0.47
9	L09	No.2	11.00 ~11.50	0.50	2.83	4.78	79.97	1.58
10	L10		15.50 ~16.00	0.50	2.84	4.43	85.25	1.16
11	L11	No.6	2.00 ~ 2.50	0.50	11.18	16.98	61.74	2.07
12	L12		2.50 ~ 3.00	0.50	11.55	17.44	60.68	2.07
13	L13	No.7	2.00 ~ 3.00	1.00	21.04	32.00	49.41	0.88
14	L14		3.00 ~ 4.00	1.00	12.86	19.80	65.94	1.21
15	L15	No.8	3.00 ~ 3.50	0.50	9.44	15.51	68.18	0.65
16	L16		8.00 ~ 8.50	0.50	3.04	5.03	83.23	1.45
17	L17		8.50 ~ 9.00	0.50	2.58	4.10	80.19	1.67
18	L18		9.00 ~10.00	1.00	1.74	2.89	81.48	0.65
19	L19		10.00 ~10.50	0.50	4.75	7.40	75.04	1.62
20	L20	No.9	2.50 ~ 3.00	0.50	11.65	17.25	65.60	1.48
21	L21		3.00 ~ 3.50	0.50	7.79	12.20	71.99	1.58
22	L22		10.00 ~10.50	0.50	4.05	6.59	79.03	1.44
23	L23		16.00 ~16.50	0.50	9.94	14.98	71.79	0.92
24	L24		16.50 ~17.00	0.50	5.67	9.20	76.31	1.55
25	L25		17.00 ~17.50	0.50	4.08	7.10	75.48	2.01
26	L26		17.50 ~18.00	0.50	8.50	13.22	75.32	1.26
27	L27		18.00 ~18.50	0.50	7.19	10.97	77.33	1.14
28	L28		18.50 ~19.00	0.50	5.66	7.32	82.81	0.74
29	L29		19.50 ~20.00	0.50	4.79	7.54	78.64	1.80
30	L30		20.00 ~20.50	0.50	6.01	8.46	85.25	0.57

No.	Sample No.	Hole No.	Depth	Sampling Width (m)	Content of Elements			
					Mn(%)	MnO_2(%)	SiO_2(%)	Fe(%)
31	L31	No.9	20.50 ~21.00	0.50	8.79	12.54	77.26	0.83
32	L32		21.00 ~21.50	0.50	21.76	32.22	54.03	0.99
33	L33		21.50 ~22.00	0.50	4.94	7.45	86.93	0.69
34	L34		22.00 ~23.00	1.00	3.11	5.19	82.60	1.49
35	L35		23.00 ~24.00	1.00	5.99	9.49	77.94	1.26
36	L36		24.00 ~24.70	0.70	10.79	17.88	66.41	1.23
37	L37	No.10	4.00 ~ 5.00	1.00	10.95	17.88	65.30	1.98
38	L38		5.00 ~ 6.00	1.00	8.25	12.28	80.25	0.71
39	L39	No.11	9.50 ~10.50	1.00	13.52	21.36	63.82	1.43
40	L40		10.50 ~11.50	1.00	22.99	34.05	53.48	0.51
41	L41	No.12	16.00 ~16.50	0.50	10.01	16.03	62.46	6.28
42	L42	No.13	12.50 ~13.00	0.50	16.23	26.32	59.27	1.37
43	L43		13.00 ~13.50	0.50	10.08	15.53	66.44	1.95
44	L44		13.50 ~14.00	0.50	5.96	9.92	72.46	1.99
45	L45		14.00 ~15.00	1.00	6.95	11.02	67.08	2.20
46	L46		15.00 ~15.50	0.50	6.47	10.10	70.32	2.30
47	L47	No.14	3.50 ~ 4.00	0.50	26.45	41.47	45.60	0.80

Table A—7 Result of X—ray Fluorescence Analysis of Chert aud Shale

	Sample No.	K-104	K-107	K-115	K-116
	Rock Name	white muddy chert	red chert	red chert	white chert
Chemical Composition	SiO_2(%)	100.24	97.31	81.05	83.52
	TiO_2	0.05	0.06	0.52	0.42
	Al_2O_3	1.22	1.34	7.68	6.62
	Fe_2O_3	0.25	0.66	4.68	2.71
	MnO	0.00	0.02	0.03	0.48
	MgO	0.12	0.32	1.77	1.78
	CaO	0.25	0.37	0.76	0.72
	Na_2O	0.15	0.20	0.19	0.20
	K_2O	0.18	0.19	1.40	1.18
	P_2O_5	0.01	0.01	0.03	0.03
	$H_2O^{(+)}$	1.46	1.81	3.77	3.56
	$H_2O^{(-)}$	(0.08)	(0.11)	(3.13)	(2.23)
	S(ppm)	130	260	370	450
	Cl	130	450	70	100
	Co	–	–	10	5
	Ni	10	–	30	50
	Cu	–	–	30	20
	Zn	–	20	50	50
	Ga	–	–	–	20
	Rb	–	16	70	35
	Sr	29	63	139	225
	Y	–	–	10	10
	Zr	10	10	100	90
	Nb	–	–	30	10
	Ba	–	–	–	–
	Pb	–	–	–	–
	Mo	–	–	–	–
	As	–	–	–	–
	V	n.d.	n.d.	n.d.	n.d.
	Cr	n.d.	n.d.	n.d.	n.d.
Total(%)		103.93	102.29	101.88	101.22