Plate III Manganese Crust

— Photographs of Samples —

05SMC12AD15_PS01~PS04

05SMC12AD16_PS01~PS04

05SMC12AD16_PS05

05SMC12AD29_PS01

05SMC12AD29_PS06~PS07

Plate IV　Manganese Crust

- Descriptions and Micrographs of Polished Sections-

Ser. No. 01

Sample No. 05SMC12AD15 PS01

Rock (ore) Name : Manganese Crust

Hand Speciment: 13cm long cross section of manganese crust. Although it is not clear but botryoidal texture of 5mm across is observed on the surface. From the surface to 8cm: Black and massive manganese oxides. Network of irregular and unclear fracture occurs entirely and limonite filling the pores of 0.5mm across is occasionally observed along the fracture. From 8cm to the end: Pale brownish gray calcareous fillings (rock fragments?) of 3 to 5mm across increases reaching to 40vol% and they occur radiating outward from inner part to surface. It has smooth surface and it does not attach to hand.

Reflection Microscope

Texture : massive to spotted

Partly shows colloform texture.

Ore Minerals

Manganese oxides (vernadite)

Mineral	Shape	Grain Size	Abundance	Descriptions
Vernadite	massive to spotted	—	85 %	Broad peak at vernadite 2.4Å.

Gangue Mineral

Polarization Microscope

Clastics :

Quartz and plagioclase fragments of volcanic origin fill interstices of manganese oxides.

Mineral	Shape	Grain Size	Abundance	Descriptions
Quartz	fragments	0.01 ~ 0.01 mm	<1 %	Volcanic origin, occurs along fracture of Mn oxides.
Plagioclase	fragments	0.01 ~ 0.03 mm	3 %	

Matrix

Fe-K-Al silicates

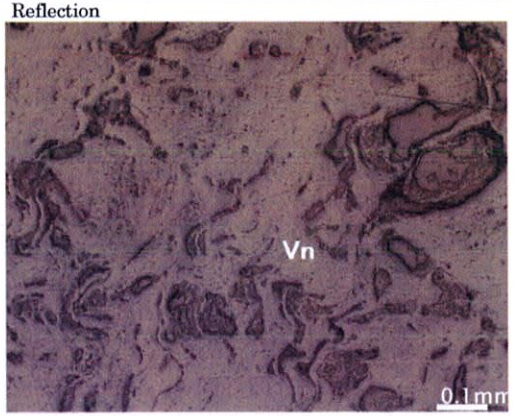
Mineral	Shape	Grain Size	Abundance	Descriptions
Fe-K-Al silicates	cryptocrystalline to amorphous	—	2 %	Coexists with manganese oxides in some of the fractures.

Alteration

Secondary Minerals

Mineral	Shape	Grain Size	Abundance	Descriptions

Reflection



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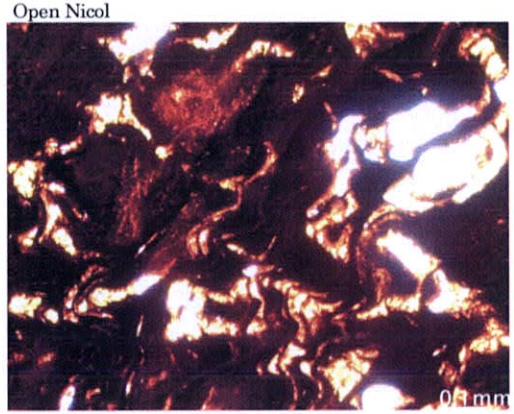

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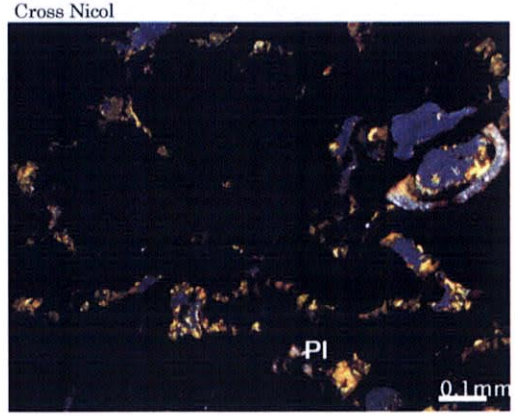


Vn: vernadite
Pl: plagioclase

Ser. No. 02

Sample No. 05SMC12AD15 PS02

Rock (ore) Name : Manganese Crust

Hand Speciment: 13cm long cross section of manganese crust. Although it is not clear but botryoidal texture of 5mm across is observed on the surface. From the surface to 8cm: Black and massive manganese oxides. Network of irregular and unclear fracture occurs entirely and limonite filling the pores of 0.5mm across is occasionally observed along the fracture. From 8cm to the end: Pale brownish gray calcareous fillings (rock fragments?) of 3 to 5mm across increases reaching to 40vol% and they occur radiating outward from inner part to surface. It has smooth surface and it does not attach to hand.

Reflection Microscope

Texture: massive to colloform

Ore Minerals

manganese oxides (vernadite)

Mineral	Shape	Grain Size	Abundance	Descriptions
Vernadite	massive to colloform	—	80 %	Broad peak at vernadite 2.4Å.

Gangue Mineral

Polarization Microscope

Clastics :

Quartz and plagioclase fragments of volcanic origin fill interstices of manganese oxides.

Mineral	Shape	Grain Size	Abundance	Descriptions
Quartz	fragments	0.02 ~ 0.03 mm	<1 %	Volcanic origin
Plagioclase	fragments	0.01 ~ 0.03 mm	5 %	Volcanic origin
Calcareous rock	shapless	~ 0.2 mm	3 %	Found in <1mm wide fracture of Mn oxides

Matrix

Fe-K-Al Silicates

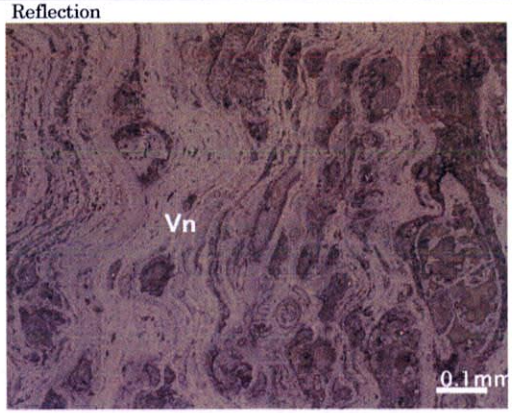
Mineral	Shape	Grain Size	Abundance	Descriptions

Alteration

Secondary Minerals

Mineral	Shape	Grain Size	Abundance	Descriptions

Reflection



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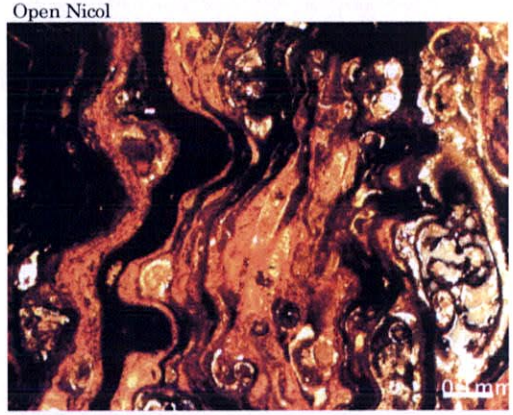

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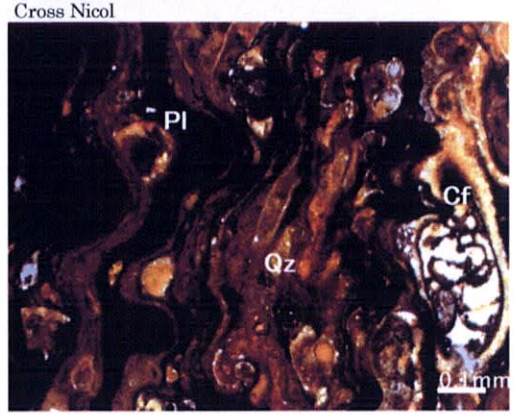


Vn: vernadite
Pl: plagioclase
Qz: quartz
Cf: calcareous fragment

Ser. No. 03

Sample No. 05SMC12AD15 PS03

Rock (ore) Name : Manganese Crust

Hand Speciment: 13cm long cross section of manganese crust. Although it is not clear but botryoidal texture of 5mm across is observed on the surface. From the surface to 8cm: Black and massive manganese oxides. Network of irregular and unclear fracture occurs entirely and limonite filling the pores of 0.5mm across is occasionally observed along the fracture. From 8cm to the end: Pale brownish gray calcareous fillings (rock fragments?) of 3 to 5mm across increases reaching to 40vol% and they occur radiating outward from inner part to surface. It has smooth surface and it does not attach to hand.

Reflection Microscope

Texture : Spotted to colloform

Partly shows stripes of 0.02cm wide.

Ore Minerals

Mn Oxides (vernadite)

Mineral	Shape	Grain Size	Abundance	Descriptions
Vernadite	spotted to colloform	—	65 %	Broad peak at vernadite 2.4Å

Gangue Mineral

Polarization Microscope

Clastics :

Quartz, plagioclase and limestone occur in fracture of manganese oxides.

Mineral	Shape	Grain Size	Abundance	Descriptions
Quartz	fragments	0.01 ~ 0.03 mm	1 %	volcanic origin
Plagioclase	fragments	0.01 ~ 0.03	3 %	volcanic origin
Limestone	sub-angular	0.1 ~ 2 mm	10 %	Foraminifera of 0.2 to 0.4mm across partly occurs.

Matrix

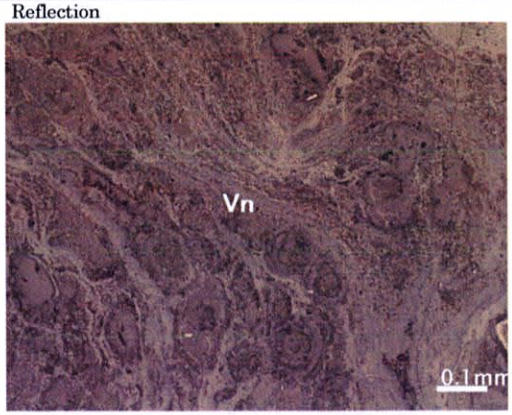
Mineral	Shape	Grain Size	Abundance	Descriptions

Alteration

Secondary Minerals

Mineral	Shape	Grain Size	Abundance	Descriptions

Reflection



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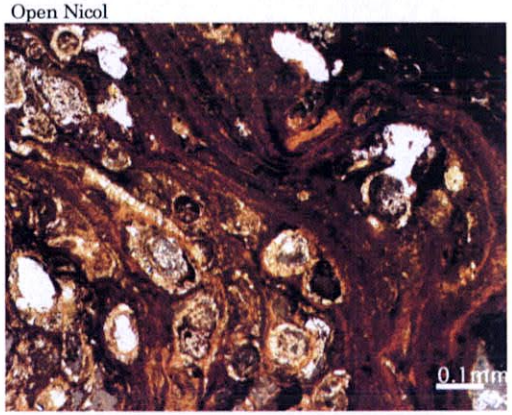

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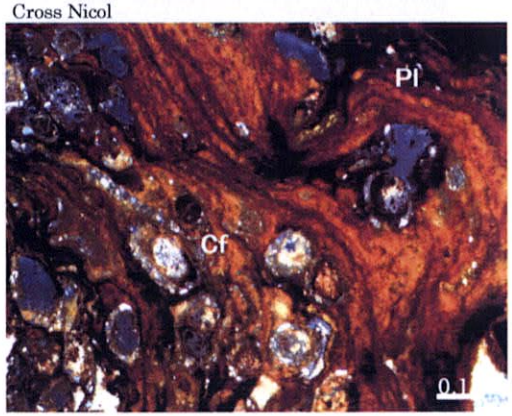


Vn: vernadite
Pl: plagioclase
Cf: calcareous fragment

Ser. No. 04

Sample No. 05SMC12AD15 PS04

Rock (ore) Name : Manganese Crust

Hand Speciment: 13cm long cross section of manganese crust. Although it is not clear but botryoidal texture of 5mm across is observed on the surface. From the surface to 8cm: Black and massive manganese oxides. Network of irregular and unclear fracture occurs entirely and limonite filling the pores of 0.5mm across is occasionally observed along the fracture. From 8cm to the end: Pale brownish gray calcareous fillings (rock fragments?) of 3 to 5mm across increases reaching to 40vol% and they occur radiating outward from inner part to surface. It has smooth surface and it does not attach to hand.

Reflection Microscope

Texture Colloform
partly spotted to network

Ore Minerals
manganese oxides (vernadite)

Mineral	Shape	Grain Size	Abundance	Descriptions
Vernadite	colloform	—	55 %	Broad peak at vernadite 2.4Å.

Gangue Mineral

Polarization Microscope

Clastics :
Quartz and plagioclase of volcanic origin are scatterd in Mn oxides. Fragments of limestone occur in fracture.

Mineral	Shape	Grain Size	Abundance	Descriptions
Quartz	fragments	0.02 ~ 0.08 mm	2 %	volcanic origin, also found in limestone
Plagioclase	fragments	<0.03 mm	2 %	volcanic origin, also found in limestone
Limestone	spotted-shapless	0.02 ~ 0.1 mm	20 %	Found in fracture. Foraminifera included.

Matrix

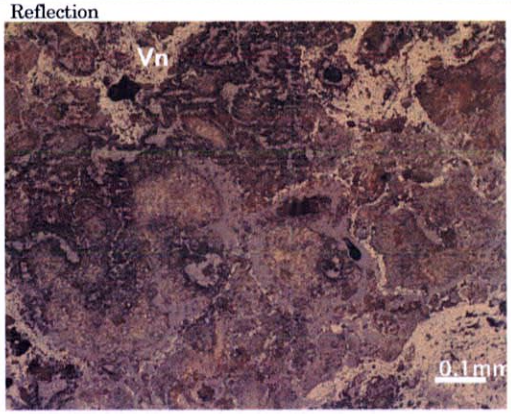
Mineral	Shape	Grain Size	Abundance	Descriptions
0				

Alteration

Secondary Minerals

Mineral	Shape	Grain Size	Abundance	Descriptions

Reflection



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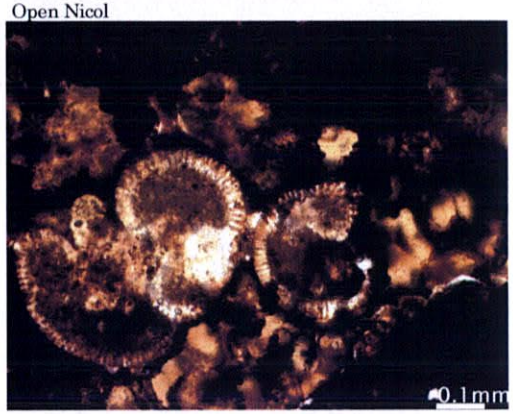

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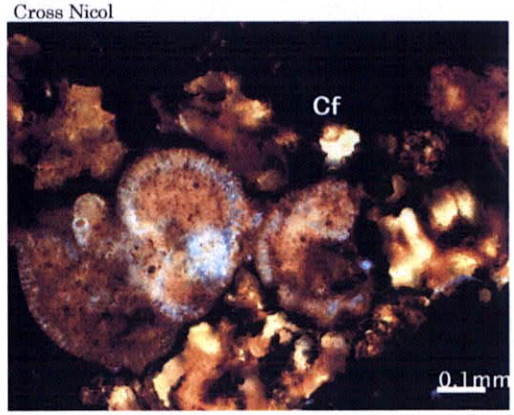


Vn: vernadite
Cf: calcareous fragment

Ser. No. 05

Sample No. 05SMC12AD16 PS01

Rock (ore) Name : Manganese Crust

Hand Speciment: 13cm long cross section of black to pale brownish gray manganese crust. The surface shows botryoidal texture of 2cm across. From the surface to below, the amount of irregular shaped patch to network of pale brownish gray calcareous fillings (rock fragments ?) increases to 30 vol. %. Pores of 1mm across are rare and unclear 2 to 3mm wide network of limonite is scattered entirely. It has smooth surface and it does not attach to hand.

Reflection Microscope

Texture : massive to spotted

Partly shows colloform texture.

Ore Minerals

manganese oxides (vernadite)

Mineral	Shape	Grain Size	Abundance	Descriptions
Vernadite	massive to spotted	–	75 %	Broad peak at vernadite 2.4Å

Gangue Mineral

Polarization Microscope

Clastics :

Quartz and plagioclase of volcanic origin occur in fractures of manganese oxides.

Mineral	Shape	Grain Size	Abundance	Descriptions
Plagioclase	fragments	0.01 ~ 0.03 mm	2 %	volcanic origin

Matrix

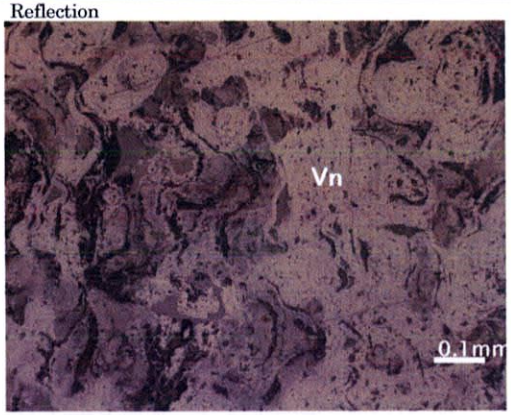
Mineral	Shape	Grain Size	Abundance	Descriptions

Alteration

Secondary Minerals

Mineral	Shape	Grain Size	Abundance	Descriptions

Reflection



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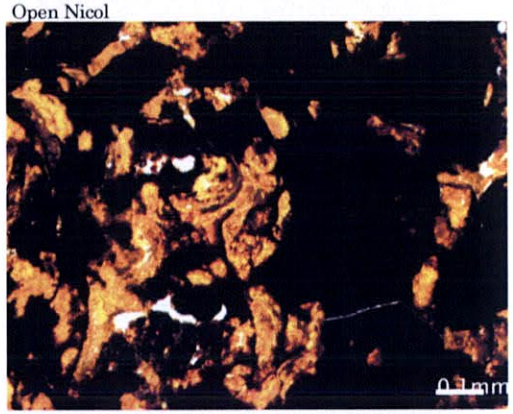

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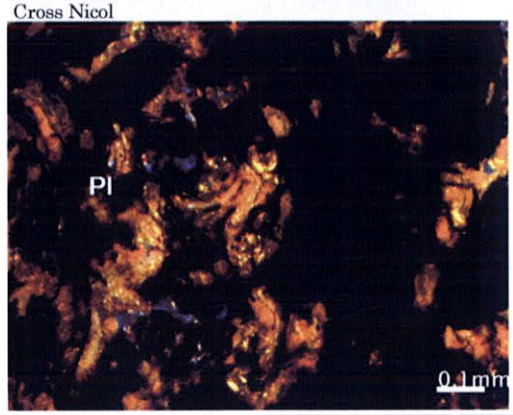


Vn: vernadite
Pl: plagioclase

Ser. No. 06

Sample No. 05SMC12AD16 PS02

Rock (ore) Name : Manganese Crust

Hand Speciment: 13cm long cross section of black to pale brownish gray manganese crust. The surface shows botryoidal texture of 2cm across. From the surface to below, the amount of irregular shaped patch to network of pale brownish gray calcareous fillings (rock fragments ?) increases to 30 vol. %. Pores of 1mm across are rare and unclear 2 to 3mm wide network of limonite is scattered entirely. It has smooth surface and it does not attach to hand.

Reflection Microscope

Texture : Spotte to Colloform

Partly shows network.

Ore Minerals

Manganese oxides (vernadite)

Mineral	Shape	Grain Size	Abundance	Descriptions
Vernadite	Spotte to colloform	—	65 %	Broad peak at vernadite 2.4Å
Pyrite	anhedral to spotted	0.03 ~ 0.05 mm	1 %	Found in pores.

Gangue Mineral

Polarization Microscope

Clastics :

Plagioclase and quartz of volcanic origin occur in fracture of Mn oxides and around limestone fragment.

Mineral	Shape	Grain Size	Abundance	Descriptions
Plagioclase	fragments	0.01 ~ 0.02 mm	<1 %	Volcanic origin
Quartz	fragments	0.02 ~ 0.1 mm	3 %	Volcanic origin, mosaic texture
Limestone	spotted to shapless	0.2 ~ 0.6 mm	15 %	Foraminifera of 0.1mm across occurs.

Matrix

Fe-K-Al Silicates

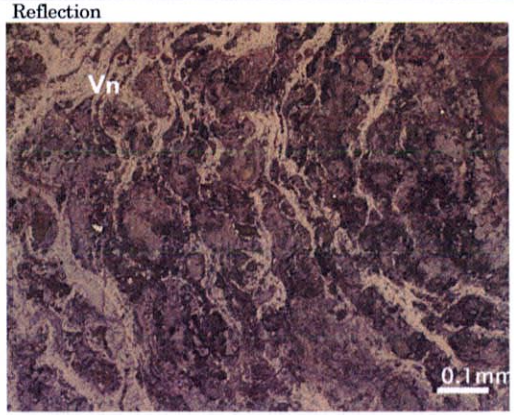
Mineral	Shape	Grain Size	Abundance	Descriptions
Fe-K-Al Silicates	cryptocrystalline to amorphous	—	5 %	Occurs in fracture of manganese oxides.

Alteration

Secondary Minerals

Mineral	Shape	Grain Size	Abundance	Descriptions

Reflection



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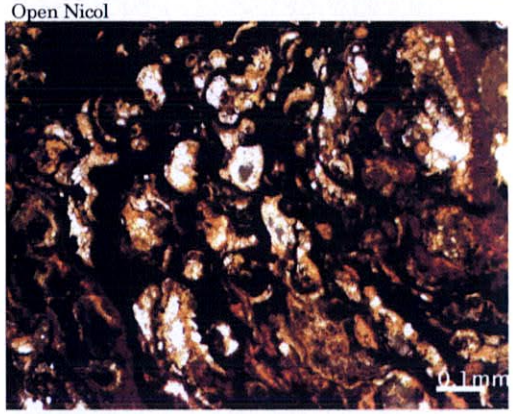

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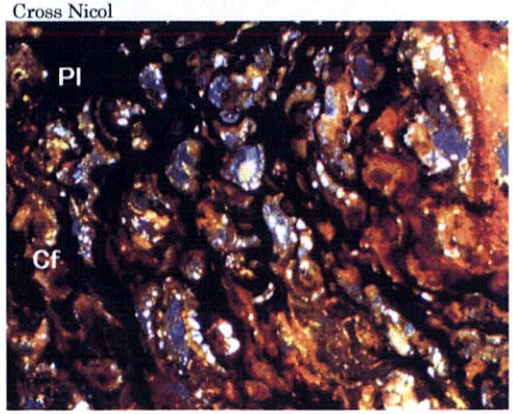


Vn: vernadite
Pl: plagioclase
Cf: calcareous fragment

Ser. No. 07

Sample No. 05SMC12AD16 PS03

Rock (ore) Name : Manganese Crust

Hand Speciment: 13cm long cross section of black to pale brownish gray manganese crust. The surface shows botryoidal texture of 2cm across. From the surface to below, the amount of irregular shaped patch to network of pale brownish gray calcareous fillings (rock fragments ?) increases to 30 vol. %. Pores of 1mm across are rare and unclear 2 to 3mm wide network of limonite is scattered entirely. It has smooth surface and it does not attach to hand.

Reflection Microscope

Texture: Spotted to network.
Partly shows colloform texture.

Ore Minerals
manganese oxides (vernadite) 、 magnetite

Mineral	Shape	Grain Size	Abundance	Descriptions
Vernadite	spotted to network	—	50 %	Broad peak at vernadite 2.4Å.

Gangue Mineral

Polarization Microscope

Clastics :
Plagioclase and quartz of volcanic origin occur in fracture of Mn oxides and around limestone fragment.

Mineral	Shape	Grain Size	Abundance	Descriptions
Quartz	fragment	0.02 ～0.04 mm	2 %	Volcanic origin
Plagioclase	fragment	0.02 ～0.4 mm	10 %	Volcanic origin
Limestone	shapless	0.3 ～6 mm	20 %	Scattered in Mn oxides, includes foraminifera.
Volcanic rock	sub-angular	0.2 mm	<1 %	Includes plagioclase of 0.02～0.03mm across

Matrix
Fe-K-Al Silicates

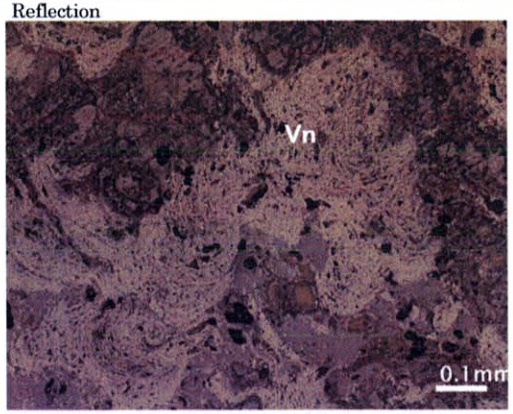
Mineral	Shape	Grain Size	Abundance	Descriptions
Fe-K-Al Silicates	cryptocrystalline to amorphous	—	5 %	Coexists with Mn oxides.

Alteration

Secondary Minerals

Mineral	Shape	Grain Size	Abundance	Descriptions

Reflection



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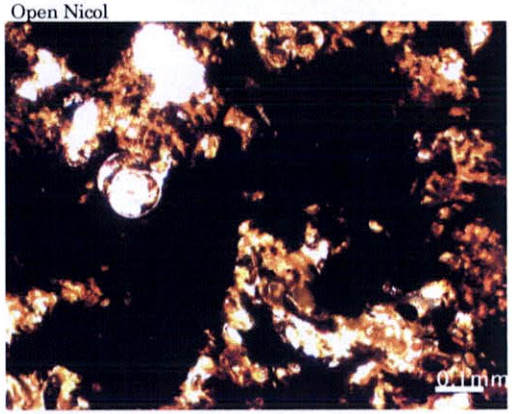

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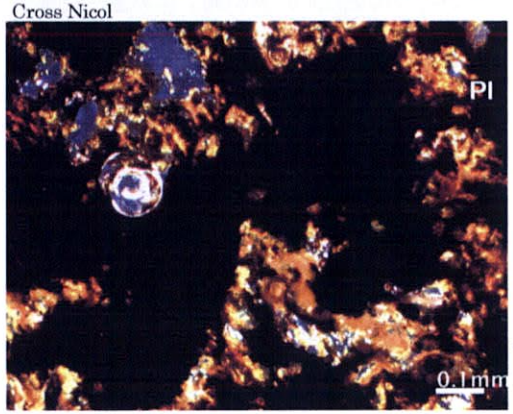


Vn: vernadite
Pl: plagioclase

Ser. No. 08

Sample No. 05SMC12AD16 PS04

Rock (ore) Name : Manganese Crust

Hand Speciment: 13cm long cross section of black to pale brownish gray manganese crust. The surface shows botryoidal texture of 2cm across. From the surface to below, the amount of irregular shaped patch to network of pale brownish gray calcareous fillings (rock fragments ?) increases to 30 vol. %. Pores of 1mm across are rare and unclear 2 to 3mm wide network of limonite is scattered entirely. It has smooth surface and it does not attach to hand.

Reflection Microscope

Texture : Spotted to network
Partly shows colloform texture.

Ore Minerals
manganese oxides (vernadite)

Mineral	Shape	Grain Size	Abundance	Descriptions
Vernadite	Spotted to network	—	60 %	Broad peak at vernadite 2.4Å.

Gangue Mineral

Polarization Microscope

Clastics :
Plagioclase and quartz of volcanic origin occur in fracture of Mn oxides.

Mineral	Shape	Grain Size	Abundance	Descriptions
Quartz	fragment	~0.06 mm	<1 %	Volcanic origin
Plagioclase	fragment	0.02 ~ 0.03 mm	5 %	Volcanic origin
Limestone	Spotted-shapless	~2 mm	25 %	Scattered in fracture of Mn oxides. Includes Foraminifera of <0.2mm across.

Matrix
Fe-K-Al Silicates

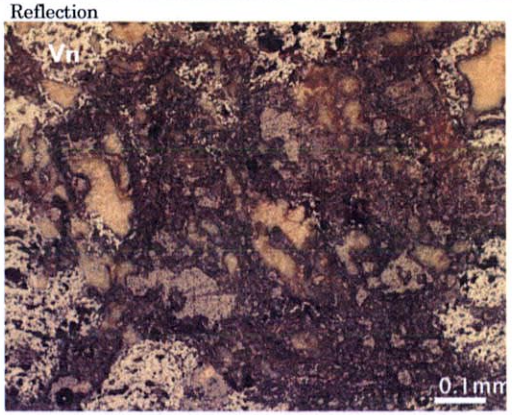
Mineral	Shape	Grain Size	Abundance	Descriptions
Fe-K-Al Silicates	cryptocrystalline to amorphous	—	3 %	Coexists with Mn oxides.

Alteration

Secondary Minerals

Mineral	Shape	Grain Size	Abundance	Descriptions

Reflection



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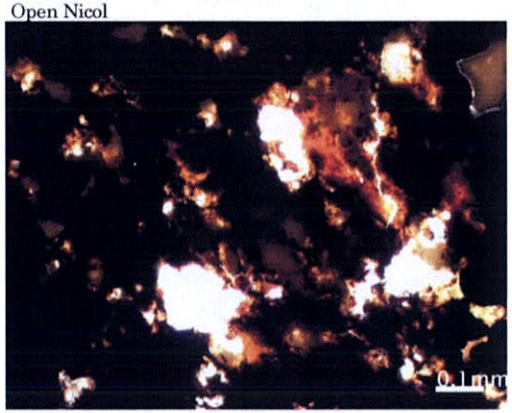

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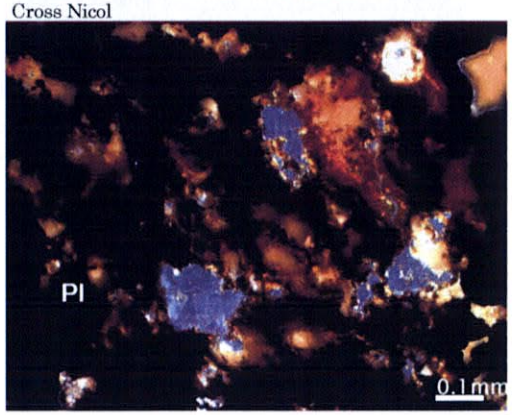

Vn: vernadite
Pl: plagioclase