REPORT No. 221
GEOLOGICAL SURVEY OF JAPAN

SPILITE AND ASSOCIATED MANGANIFEROUS HEMATITE DEPOSITS OF THE TOKORO DISTRICT, HOKKAIDO, JAPAN

By

Takeo BAMBA & Toshiaki SAWA

GEOLOGICAL SURVEY OF JAPAN

Hisamoto-chō, Kawasaki-shi, Japan

1 9 6 7

552.3+553.31(524)

REPORT No. 221

GEOLOGICAL SURVEY OF JAPAN

Konosuke SATO, Director

Spilite and Associated Manganiferous Hematite Deposits of the Tokoro District, Hokkaido, Japan

By

Takeo BAMBA & Toshiaki SAWA

CONTENTS

Page

I. Introduction ··· 1
II. General Geology ··· 2
II. 1 Tokoro-Toyokoro metallogenic province ··· 2
II. 2 Geology of the Tokoro mining district ··· 3
III. Manganiferous Hematite Deposits ··· 4
III. 1 Occurrence of the ore deposits ··· 4
III. 2 Spilite ··· 5
III. 2. 1 Spilite in mineralized belt ··· 6
III. 2. 2 Spilite in barren belt ··· 7
III. 2. 3 Descriptions on spilite and associated keratophyre ··· 7
III. 2. 4 Spilite problems in the Tokoro mining district ··· 8
III. 3 Chert ··· 9
III. 4 Special rock facies (Ferruginous quartz siderite rock) that developed between chert and spilite ··· 10
IV. Descriptions of Representative Ore Deposits in the Mining District ··· 11
IV. 1 Ore deposit in the Shibayama mine ··· 11
IV. 2 Ore deposit in the Kokuriki mine ··· 13
IV. 3 Ore deposit in the Nikura mine ··· 13
IV. 4 Ore deposit in the Hokko mine ··· 14
IV. 5 Ore deposit in the Poronai mine ··· 15
IV. 6 Ore deposit in the Fukuyama mine ··· 16
V. Ores and Ore Minerals ··· 18
V. 1 Low grade disseminated ore ··· 18
V. 2 Spotted ore and dense massive ore ··· 18
V. 3 Special ore composed of coarse hematite crystals ··· 18
V. 4 Penwithite ··· 19
VI. Genesis of the Ore Deposits ··· 19
Acknowledgements ··· 20
References ··· 20
要　旨
Plates 1 ～ 17

Spilite and Associated Manganiferous Hematite Deposits of the Tokoro District, Hokkaido, Japan

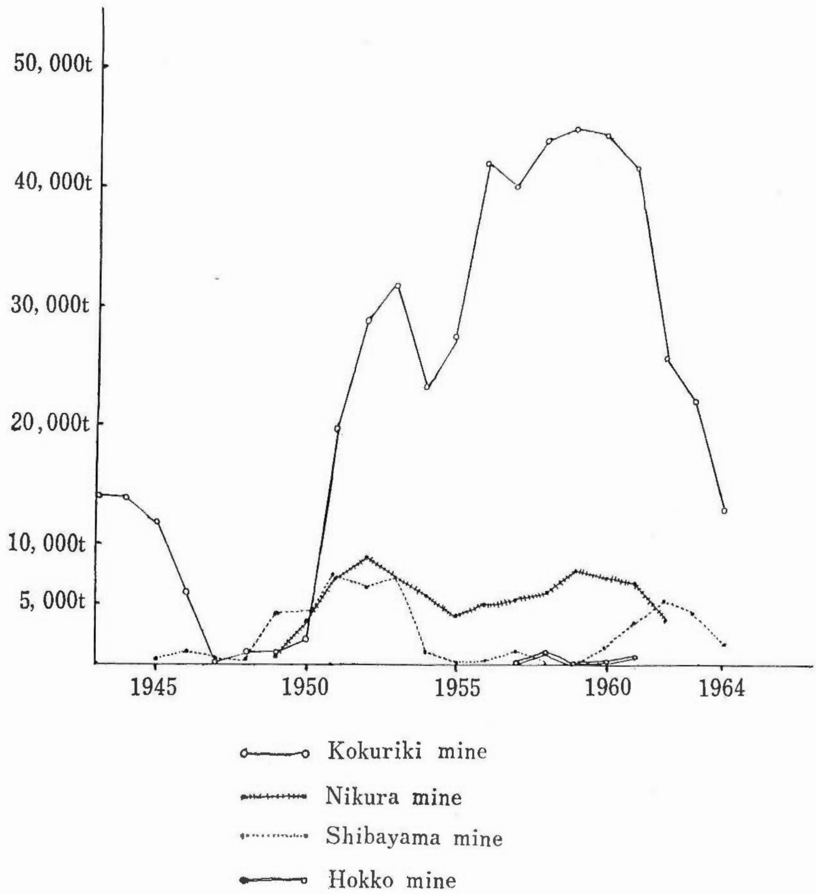
By

Takeo BAMBA & Toshiaki SAWA

I. Introduction

Geological investigations of the Tokoro mining district have been begun since 1950 by Geological Survey of Japan (ASAHI, N. & SAITO, M., 1953). The present authors (BAMBA, T. & MATSUMURA, A., 1962, BAMBA, T., 1963, BAMBA, T., 1964, BAMBA, T. & SAWA, T., 1965) have touched upon the studies during recent several years.

Table 1 Annual productions from the main four mines in the Tokoro mining district, Japan



Various kinds of mineral deposits are known in the mining district. Most of them belong to the mineralization of Jura-Cretaceous in age, closely related to spilite-diabase activities. They are manganiferous hematite deposits, bedded manganese deposits, cupriferous pyrite deposits and silica stones. Among them, the manganiferous hematite deposit is the most important, because it had been worked during twenty years since 1943 and the total product of the ore had been arrived at 500,000 metric tons. Consequently, spilite and associated manganiferous hematite deposits have been mainly undertaken.

In general, manganiferous hematite deposit resembles to cupriferous pyrite deposit in geological environments and in their occurrences. Thus the comparison between them is very interesting for the consideration of the genesis of them, as noted by T. WATANABE (1957).

The present authors have a great interest to the problem also, especially on a relation between spilite and manganiferous hematite deposit or between diabase and cupriferous pyrite deposit, because initial magmatism represented by spilite or diabase activities in geosynclinal basin seems to be closely related to the origin of these ore deposits. Thus this paper will play a role of preliminary note for the project.

II. General Geology

II. 1 Tokoro-Toyokoro metallogenic province

Geosynclinal sediments of the Hidaka mountainland in the central Hokkaido are occupied by muddy or silty rocks and basic pyroclastic layers of Mesozoic era, especially they are

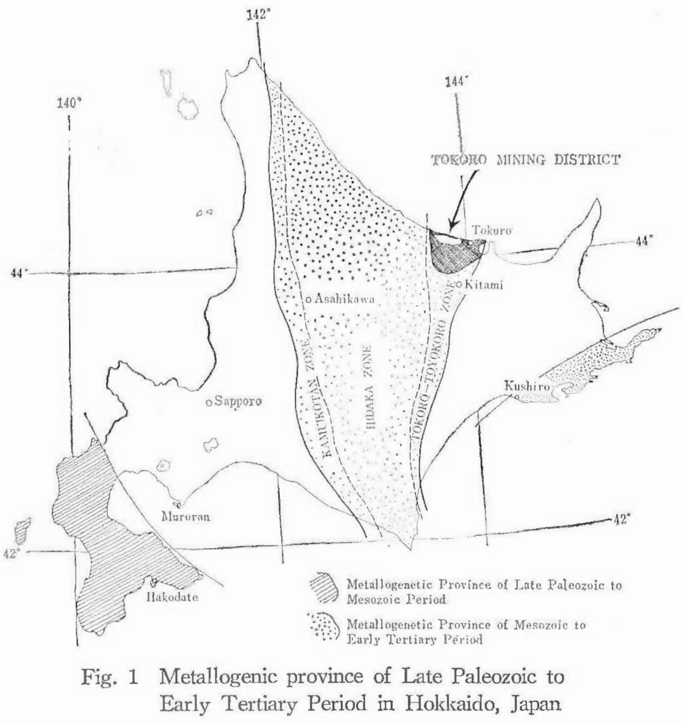


Fig. 1 Metallogenic province of Late Paleozoic to Early Tertiary Period in Hokkaido, Japan

predominant in those of Jura-Cretaceous in age, they were folded in early Tertiary period as the result of Alpine orogeny which is called "Hidaka orogenic movement" and three characteristic tectonic zones were formed. The central zone including metamorphic belt is called "Hidaka zone". The eastern end of this zone is characteristic in spilite activities in the geosynclinal stage and is called "Tokoro-Toyokoro zone". On the other hand, the western belt which is parallel to the Hidaka zone has special properties represented by serpentine intrusions and plenty kinds of quartz schist, then this zone is called "Kamuikotan zone".

Migmatite, gneiss and hornfels were formed in the core of the Hidaka orogenic zone. Remarkable igneous intrusions are noticed in the metamorphics. The igneous activities may be classified into two main series. One of them is gabbroic rock series and the other is granitic rock series. The former is more predominant than the latter, and in general, they show remarkable schistosities. Various kinds of mineral deposits related to the igneous activities are known. Some of them are very valuable, especially, cupriferous pyrite deposits of the Shimokawa mine, asbestos and chromite deposits of the Kamuikotan zone, manganiferous hematite deposits of the Tokoro district are famous.

As the accumulation of geosynclinal basin proceeded, some kinds of mineral deposits were formed. They are limestone, silicastone, manganiferous hematite deposits and bedded manganese deposits. Limestones are found everywhere in this province, but the others are limited in two or three localities. Silicastones, bedded manganese deposits and valuable manganiferous hematite deposits are found in the northern part of Tokoro-Toyokoro zone.

II. 2 Geology of the Tokoro mining district

The Tokoro mining district is situated on the northeastern side of the central zone of Hokkaido, which belongs to Tokoro-Toyokoro metallogenic province.

Geology of the mining district is composed of mudstone, sandstone and various kinds of diabasic rocks as members of Mesozoic formations and muddy or silty sediments, andesite and rhyolite believed to be Neogene Tertiary in age.

Quaternary system is characterized by plenty quantities of pumice flow. The distributions of those formations are illustrated in Fig. 2.

Neogene Tertiary system develops surrounding the Tokoro river showing basin structure with N30°E trend. The formation is often intruded by andesitic and rhyolitic dykes. In general, these intrusions are controlled by dome structure of Mesozoic formations. The tectonic of the area is characteristic in NNE direction which is called "Kitami-Tokoro direction".

Distributions of Cretaceous mudstone formation, diabasic rocks, Neogene Tertiary formations are parallel to the direction. It is regarded that the direction is controlled strongly by the tectonic of the basal formations, and the tectonic is reflected topographically also such as the direction of rivers and the mountain range. However, surrounding the manganiferous hematite deposits, special local structure characterized by E-W trend is noticed.

The distribution of the ore deposits is limited in the area occupied by diabasic rocks. Main ore bodies are known in the Hokko, Nikura, Kokuriki and Shibayama mines. They distribute within a narrow belt showing N-S trend. The width of the belt is about 2 km and the length of the belt is about 15 km. Consequently, the structure of NNE trend is called "Primary structure" and the E-W structure which running N-S trend is called "Secondary structure". It seems that the mineralization may be closely related to the formation of secondary structure and diabase activities.

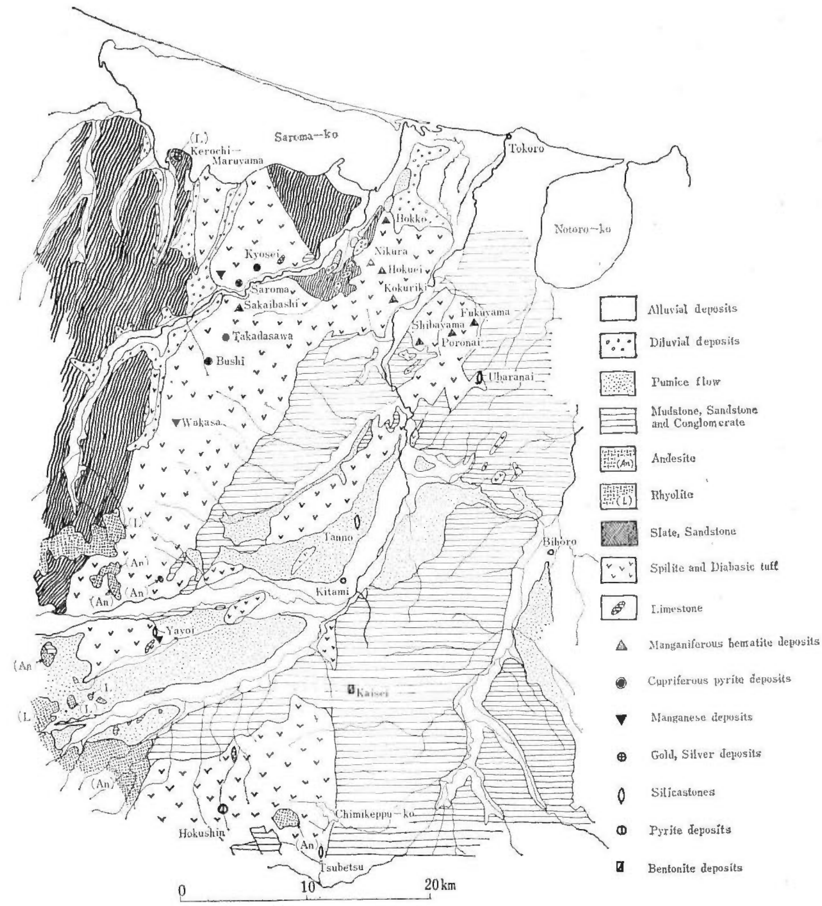


Fig. 2 Geology and distribution of mineral deposits in the Tokoro province

III. Manganiferous Hematite Deposits

III. 1 Occurrence of the ore deposits

In general, manganiferous hematite deposits of the Tokoro district occur in irregular lens or bed form, and develop between red chert layer and spilitic lava. It is common that the former is hanging wall and the latter plays a role of foot wall. The stratigraphic horizon germinated ore deposits seems to be fixative.

It is testified by facts that in a restricted area, mineralized horizon is stationary at least. Thus they can follow up the bonanzas stratigraphically. However it is not the meaning that the origin of the deposits should be illustrated by syngenetic theory.

The greatest ore deposit in the mining district is that of the Kokuriki mine. In the mine, several bonanzas are known along the same horizon stratigraphically through 1,000m. Unfortunately, the present authors cannot yet clarify the extension of the deposit along the dip trend, because bonanzas often disappeared by thrusts or faults in deep galleries, though the present authors recognized that the bonanzas developed from open pit as far as 200m in depth. In the mining district, main parts of ore deposits develop underground, but in northern part of the region, peculiar type of ore which belongs to a kind of residual deposit is known, especially in the Hokko mine, plenty of ore pebbles are found in soil mantle on a hill. The hill is composed of diabasic rock and no chert layer playing a role of hanging wall develop.

It is regarded that the deposits had developed accompanying with chert layer in older time.

The ore deposits in the Nikura mine are situated in more superficial than those of the Kokuriki mine. Compared it with those of the Hokko mine, it is more deep from the erosion surface. Thus the present authors have arrived at a conclusion that the northern part of the mining district is more erosive than that of the southern part. It is true that in northern area of the mining district, peculiar amphibolite believed to be Paleozoic in age occur showing "Fenster".

Generally, ore deposits are separated into several bonanzas in the fixed stratigraphic horizon. Between each bonanza, particular rock facies represented by ferruginous quartz and siderite develop. Appearance of the rock resembles very much to that of ore.

III. 2 Spilite

The mining district is mostly occupied by spilitic lavas or pyroclastic sediments. The rock properties of them are various, they are classified into several rock facies: viz. diabasic tuff, spilite and a kind of agglomerate. Among them, spilite is the most predominant. It is generally so massive and sometimes shows pillow form that the present authors cannot measure directly the dip or strike of the lava formations. Thus the formations must be followed by thin chert layers assosiated with the lavas.

Plenty numbers of manganiferous hematite deposits develop closely related to chert layer in the spilite, however the mineralized area is limited within narrow belt running N-S

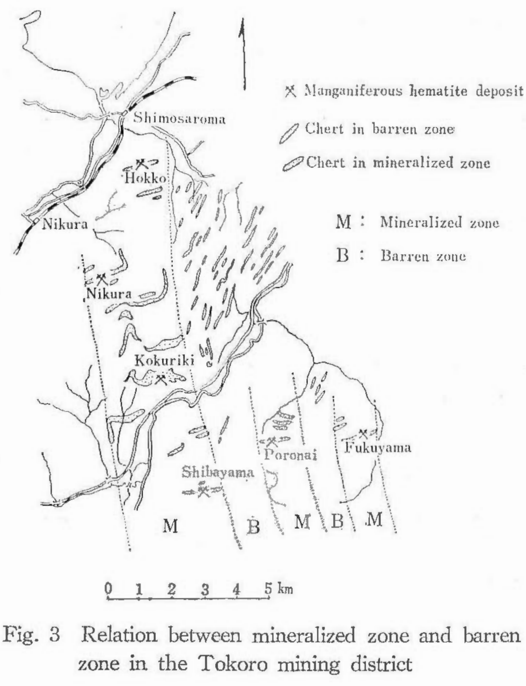


Fig. 3 Relation between mineralized zone and barren zone in the Tokoro mining district

trend which shows two or three kilometers in width. Outside of the narrow mineralized belt, no mineral deposit has been found, thus the outer zone of the mineralized belt is called "barren belt".

The present authors want to touch upon the spilite problems in the mineralized belt and in those of the barren belt also.

III. 2. 1 Spilite in mineralized belt

Occurrences of spilite are generally massive, and sometimes it develops showing pillow form or looking agglomerate, however the rock properties do not always correspond to the various occurrences. Spilite is classified into three rock facies according to the texture under the microscope.

Type-A: Spilite rich in glass characterized by variolite or subvariolite texture showing brownish tint. Sometimes, small amounts of needle of plagioclase are seen in it. In this facies, segregative calcites are common.

Type-B: Spilite composed of small crystals of diopsidic pyroxene, plagioclase and titanite. Subophitic texture is distinct. Usually small amount of glass and variolite texture composed of glass and needles of plagioclases are observed in this facies.

Type-C: Spilite characterized by coarse-grained crystals of titaniferous augite showing brown tint, and intergranular plagioclase and ilmenite. Ophitic or subophitic texture by augite and plagioclase is remarkable. In general, titanite has been replaced by ilmenite completely. Subophitic texture which looks like relics of the type-B is often found in this facies.

These three rock types are regarded to show familiar relation to each other, and may be illustrated that type-C is reflected slow cooling phase and type-A is represented rapid cooling phase.

In general, the type-A of spilite occur in the uppermost of the lava flow. It is true that the facies develop widely as foot wall of the manganiferous hematite deposits in the Kokuriki mine.

Thus the present authors came to a conclusion that the three facies must be one set in a unit of spilitic lava. They followed and investigated petrographically a unit of spilitic lava in the Kokuriki mine area, in the Shibayama mine area and in the Hokko mine area from the bottom of a chert layer to the uppermost of the other underlying chert layer. The three facies develop in it very complicatedly. In general, the serial rock facies represented by types -A, -B, -C repeats several times among two chert layers. Consequently it must be explained that the activities of spilitic lavas had repeated until the next accumulation of cherty materials.

The phenomena described above are very common through the mineralized belt. In field the present authors cannot distinguish the differences of primary rock facies between northern part and southern part of the belt. However they recognized the other interesting phenomena on secondary metamorphic facies in the belt.

The secondary metamorphic facies are characterized by remarkable chloritization and albitization. The grade of the chloritization and albitization of the spilite in the northern part of the belt is more predominant than that in the southern area. It may be explained that the spilite formation in the northern part of the belt might be more erroded out until older amphibolite formation, thus the spilitic formation in the northern area must play a role of basal layers in the mining district. The origin of the chloritization and albitization in this belt may be explained as a result of steeping in a closed system with high pressure caused by shearing stress.

III. 2. 2 Spilite in barren belt

The barren belt extends on the eastern side of mineralized belt showing three or four kilometers in width. The belt is composed of numerous thin chert layers running N30°E trend and plenty numbers of spilitic lavas.

The present authors investigated the spilitic lavas in two areas, one is the Toyokawa area and the other is the Tomioka area. The latter is situated on the anticlinal axis geotectonically and the former is correlated to southern wing of the anticline, thus spilite in the Tomioka area is regarded to belong more deep facies than that of the Toyokawa area.

They found remarkable differences of rock properties compared with those of the mineralized belt. Usually, two or three rock facies are realized in a thin section microscopically. Facies variaton is very distinct, for example, typical subophitic textures which belong to type-B are often realized in glassy variolite facies of type-A, thus it resembles to a kind of porphyritic texture. The three rock facies are not independent to each other. On the other hand, chloritization or albitization in spilite is noticed in this belt also. In the Tomioka area, chloritized spilite is predominant. It is regarded that the area is correlated to the most deep niveau in the barren belt as well as the northern part of the mineralized belt. They can find another chloritized spilite in the Toyokawa area where seems to be fractured strongly. The chlorites in this facies show more dark green tint in thin section compared with those of the Tomikawa area.

The present authors must touch upon the problem on the occurrence of sodaclase-keratophyre. No keratophyre has been found in Hokkaido, especially keratophyre which belongs to Mesozoic era is not very common in Japan, thus the discovery of the rock has an important geologic significance. The sodaclase-keratophyre occurs showing flake-like form in a spilite lava that developed in the Toyokawa area where situated on the anticlinal axis of the barren belt.

III. 2. 3 Descriptions on spilite and associated keratophyre

More or less of chloritization and albitization are generally observed through the whole facies of spilite. In this description, present authors intend to note on the original rock facies as much as possible.

Type-A: Tortoise shell structure of glass is common and the dimension is about 0.3mm (Plate VIII, Fig. 18, Plate X, Figs. 25, 26). Sometimes granular titanite and needles of plagioclase are formed in it (Plate IX, Fig. 22, Plate XI, Figs. 29, 30).

Type-B: Subophitic texture formed by pyroxene and plagioclase is distinct. Pyroxenes are diopsidic and show agregates as leaves of cypress. Longitudinal dimension of the crystals are 0.02mm (Plate VIII, Figs. 19, 20, Plate IX, Fig. 24, Plate X, Fig. 27). Crystal form of plagioclase is needly, plagioclase is characterized by albite twinning showing 30°± of maximum symmetric extinction angle.

Type-C: Subophitic texture is distinct, which is composed of common augite, plagioclase and ilmenite (Plate VIII, Fig. 21, Plate X, Fig. 28, Plate XI, Fig. 32). The size of them is generally 0.3mm. Sometimes more coarse crystals (1mm) are seen, which is characterized by titaniferous augite showing pinkish tint (Plate XII, Fig. 33). But this facies is believed to be reflected hypabyssal phase in a later stage of the serial volcanism.

Sodaclase-keratophyre:

The trachytic groundmass is made up chiefly of very small laths of feldspar, averaging 0.01×0.1mm which is untwinned (Plate XII, Fig. 34).

There is also a small amount of chlorite and green hornblende. Original ferromagnesian minerals are entirely absent from the groundmass but scattered through the feldspar there are iron ores and other alteration products which may represent an original mafic mineral.

This facies develops as flake-like form showing leucocratic gray tint in basal spilitic green rocks.

Chemical composition of the rock is shown in Table 2-(4). The value of main components and the rock properties resemble to typical sodaclase-keratophyre from Germany described by A. JOHANNSEN in 1937.

Table 2 Chemical compositions of spilites and associated sodaclase-keratophyre in the Tokoro mining district

	(1)	(2)	(3)	(4)	(5)
SiO_2	48.88	47.40	47.36	66.10	45.22
TiO_2	1.48	1.14	1.10	0.36	3.00
Al_2O_3	14.56	15.35	14.22	16.55	15.42
Fe_2O_3	3.55	3.11	3.88	4.65	5.77
FeO	7.52	6.29	6.78	0.78	6.03
MnO	0.19	0.15	0.19	0.06	0.19
MgO	6.31	8.53	8.07	0.56	6.06
CaO	10.80	11.18	12.05	3.01	7.03
Na_2O	2.82	1.82	2.05	6.19	2.73
K_2O	0.05	0.75	0.13	0.01	1.21
P_2O_5	0.08	0.08	0.08	0.06	0.41
$H_2O(+)$	3.06	3.70	3.52	1.40	4.96
$H_2O(-)$	0.42	0.44	0.40	0.26	1.88
Total	99.72	99.94	99.83	99.99	99.91

Analysts: K. Maeda & M. Kawano (Geological Survey of Japan)

(1) Glassy spilite illustrated in Plate X, Fig. 25
(2) Variolitic spilite illustrated in Plate X, Fig. 26
(3) Subophitic spilite illustrated in Plate X, Fig. 28
(4) Sodaclase-keratophyre illustrated in Plate XII, Fig. 34
(5) Ophitic diabase characterized by titaniferous augite illustrated in Plate XII, Fig. 33

III. 2. 4 Spilite problems in the Tokoro mining district

It is believed that the initial magmatism in the geosynclinal basin of the Tokoro mining district is represented by large quantities of spilitic lavas. They are classified into three types such as glassy facies, variolitic facies and subophitic facies as described above. The three facies are closely related to each other in their occurrences and in their textures under the microscope also. No variation is noticed in the chemical compositions between them, thus it is regarded that the volcanic activities represented by the three facies must be realized in a same stage as the earliest volcanism in the geosynclinal basin. The variation of rock properties under the microscope must be only caused by slight differences of P-T condition. Type-A (glassy facies) is regarded to be reflected the rapid cooling phase and the other types seem to be reflected the slow cooling phase. It is true that they occur showing irregular form compensated to each other in a massive outcrop.

Sodaclase-keratophyre and coarse ophitic diabase characterized by titaniferous augite are regarded to be formed in a later stage of the serial volcanism, because they occur on a anticlinal axis of the basal spilitic formations. Sodaclase-keratophyre is more rich in Na_2O and SiO_2 than that of the basal spilites described above and coarse ophitic diabase is characterized by increase of K_2O, thus the volcanic activities in the geosynclinal basin must be illustrated that the chemical component of the basaltic magma varies to more alkalic in a later stage, however, the values of chemical analysis indicate also that the basaltic magma should be differentiated into two directions in chemical trend. One is characterized in soda and the other is characterized in reasonable amount of potassium.

Present authors came to a conclusion that the basal spilite and the successive intrusions represented by sodaclase-keratophyre or coarse ophitic diabase are closely related to each other in their origin. Interpretation or secondary metasomatism are hardly noticed in the latest phase of the volcanisms. Slight carbonitization, chloritization or albitization may be explained that they are caused by autometamorphism during deuteric stage.

Typical spilite characterized by high percentage of soda has been known in the Tokoro mining district, however, the texture and structure of the rock is the same compared with the general spilite described above. The heterogeneous distribution of soda within the spilitic lava is considered to be the result of diffusion operating during the deuteric stage.

III. 3 Chert

In the mining district, numerous thin red chert layers develop in spilitic lavas, they show 10 meters or less in thickness and lamination is very distinct. The unit lamina of them is generally 2 or 3 cm, but sometimes they show massive.

The extension of them is very complicated as the result of folding or faults. In general, along the folding axis, numerous minor quartz veins develop.

According to microscopic investigations, plenty of radioralias or their relics replaced by calcedonic quartz are found.

In the Kokuriki mine area, the chert layers which played a role of hanging wall show 100 m or more in thickness, thus present authors investigated the rock properties and its vertical chemical variations on Fe and Mn by a systematic sampling between the bottom and the uppermost of the layer in two points as follows:

Table 3 Vertical variation of chert layer in the Kokuriki mining area

Nos. of handspecimen		Notes of thin section	Fe (%)	Mn (%)
Upper	210	Network quartz veins develop in dark red chert. Radioralias replaced by calcedonic quartz are found.	3.2	0.2
	209	Embryos of coarse crystals of quartz develop in light red chert. No radioralia is seen.	2.7	0.0
	208	A small amount of embryos of coarse crystals of quartz are found.	2.4	0.0
	207	A small amount of radioralia replaced by calcedonic quartz is seen and a little quantity of network quartz veins are found.	3.1	0.0
100m	206	Composed of small fragments of chert and network quartz veins.	2.3	0.1
	205	Resembles to #206 described above, rich in segregative quartz.	3.8	0.2
	204	Microcrystals of hematite are found in massive muddy chert.	4.0	0.4
	203	Fragments of muddy chert are found in segregative quartz vein, hematite crystals develop in the quartz veins.	3.6	0.2
Lower		Manganiferous hematite deposits	30.0	10.0

Table 4 Vertical variation of chert layer in the Kokuriki mining area (Distance between the point shown in Table 3 and that in Table 4 is about 300m., and the point shown in Table 4 is eastern side of the former)

	Nos. of handspecimen	Notes of thin section	Fe (%)	Mn (%)
Upper	213	Piedmontite quartz bearing siliceous chert.	4.1	0.3
	214	Light red chert cut by network quartz veins. In which microcrystalline hematites develop.	3.5	0.6
	215	Dark red chert cut by small amount of quartz veins.		
	216	Aggregates of fragments of chert and quartz.	4.4	0.1
	217	Dark red muddy chert containing plenty of radioralias.	6.3	0.4
	218a	Same to #217	3.5	2.3
Lower	218b	Semi-ore composed of hematite, chlorite and quartz, in the quartz, needly hematites are seen.	11.4	0.4

Thus it has been clarified that the variations of rock properties of chert have noticed in vertical directions and no variation has been found horizontally within 300m at least.

III. 4 Special rock facies (Ferruginous quartz siderite rock) that developed between chert and spilite

In general, manganiferous hematite deposits in the Tokoro mining district develop

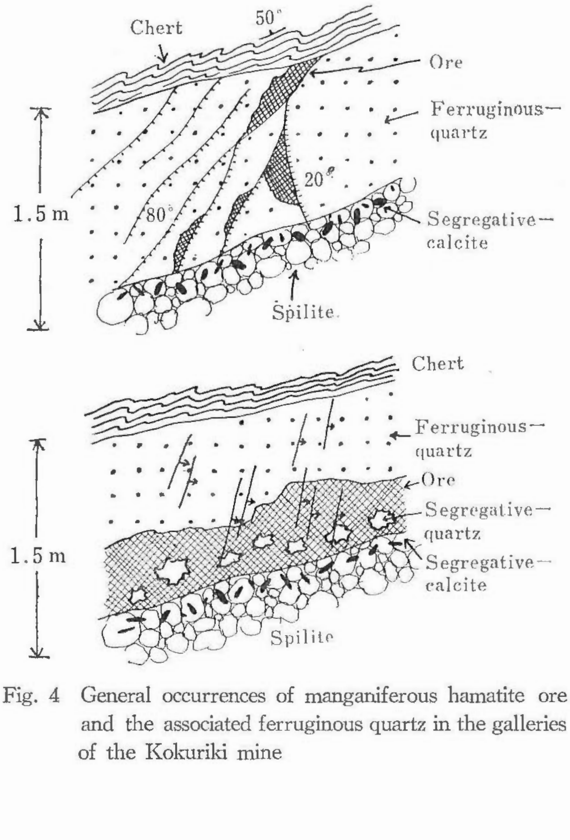


Fig. 4 General occurrences of manganiferous hamatite ore and the associated ferruginous quartz in the galleries of the Kokuriki mine

Errata of lines 10~21 from the top, page 11. (Report No. 221)

Ferruginous quartz is 0.01mm in size showing spheloidal textures by aggregation of small crystals (Plate XIV, Fig. 39), color is brown and no pleochroism is seen. Indices are measured as follows: $n_o=1.541$, $n_e=1.533$, $n_o-n_e=0.008$

On the other hand, segregative quartz is quite different from the former. Color is white and show graphic texture (Plate XIV, Fig. 42). Indices of the quartz are given as below: $n_o=1.539$, $n_e=1.532$, $n_o-n_e=0.007$

Siderite occurs as aggregating spherical form in ferruginous quartz mass, the dimension of the spherical part is about 0.2mm. Thus the texture of the ferruginous quartz siderite rocks looks like porphyroblastic rock by spotted aggregates of siderites (Plate XIV, Fig. 40).

Hematites in the rock are very fine and show intergranular texture with ferruginous quartz. Crystal form of the hematite is generally platy hexangular (Plate XIV, Fig. 41, Plate XIV, Fig. 42).

showing irregular lens form between chert and spilite.

In the mineralized horizon, special rock facies mainly composed of ferruginous quartz and siderite are found instead of ores. The occurrences of the special rocks are shown in Figure 4.

The tint of the rock is reddish brown, and the rock properties are massive. The joint system developed in the facies is just the same to that of the ores occurred surrounding the siderite bearing ferruginous quartz rocks.

Mineral components of the rock are ferruginous quartz, siderite, hematite and segregative white quartz.

Ferruginous quartz is 0.01mm in size showing spheloidal textures by aggregation of small crystals (Plate X, Fig. 27), color is brown and no pleochroism is seen. Indices are measured as follows: $n_o=1.541$, $n_e=1.533$, $n_o-n_e=0.008$

On the other hand, segregative quartz is quite different from the former. Color is white and show graphic texture (Plate XI, Fig. 30). Indices of the quartz are given as below: $n_o=1.539$, $n_e=1.532$, $n_o-n_e=0.007$

Siderite occurs as aggregating spherical form in ferruginous quartz mass, the dimension of the spherical part is about 0.2mm. Thus the texture of the ferruginous quartz siderite rocks looks like porphyroblastic rock by spotted aggregates of siderites (Plate X, Fig. 28).

Hematites in the rock are very fine and show intergranular texture with ferruginous quartz. Crystal form of the hematite is generally platy hexangular (Plate X, Fig. 27, Plate XI, Fig. 29).

Present authors can easily distinguish it from the other hematite which formed ore. The hematite is regarded to be formed in the first phase of the mineralization, thus the present authors called it "hematite-I"

Among these four minerals described above, ferruginous quartz, siderite and hematite-I are regarded to show a equilibrium relation to each other and segregative white quartz must be excepted from the equilibrium relation. White quartz may be illustrated as well as segregative calcite occurred in the bottom of special rock facies. Because they are regarded to be caused as the result of metasomatic differentiation in a mineralization phase characterized by Fe replacement.

IV. Descriptions of Representative Ore Deposits in the Mining District

IV. 1 Ore deposit in the Shibayama mine

The Shibayama mine is situated in southern end of the mining district. The ore deposit of the mine has been worked during recent twenty years.

Geology of the mining area is composed of spilitic lava, chert layers of Mesozoic era. The distribution of them and the geologic structure are shown in Fig. 5.

In the mining area, general trend of chert layers is E-W showing synclinal structure. Present authors can find two chert layers but the ore deposits are related to one of chert layers, which develop on outer side of the synclinal axis.

The chert layer which associated ore deposits is more siliceous than that of the other. The rock properties of spilitic lavas are various. Along the synclinal axis, glassy spilite showing variolite texture develops.

In both wings of the folding axis, spilite which characterized by inter-granular texture of pyroxene and plagioclase (Plate XI, Figs. 29, 30, 31, 32) is found.

Two rock facies described above are regarded to be closely related to each other, for

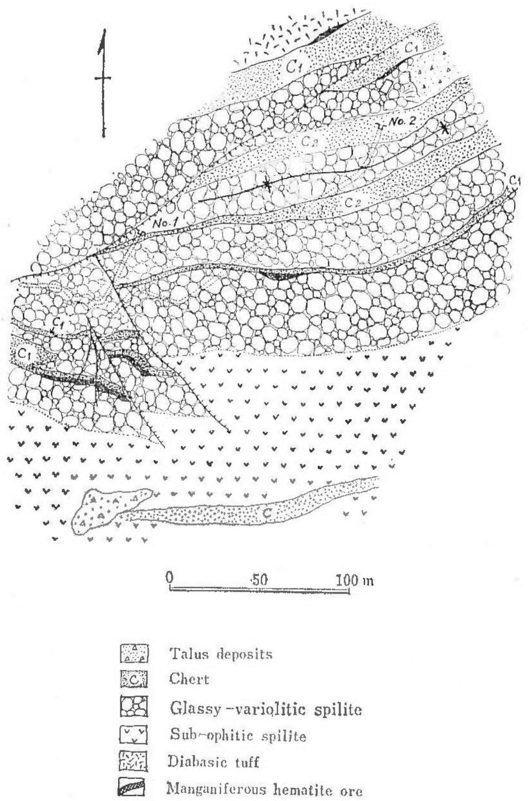


Fig. 5 Geological map of the Shibayama mine

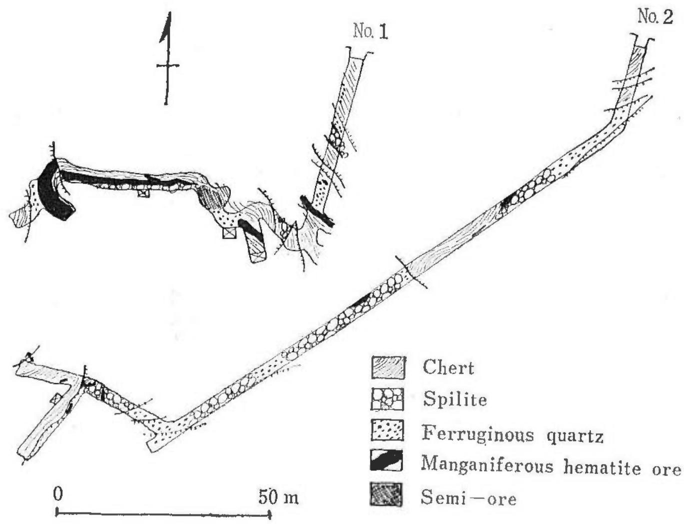


Fig. 6 Occurrence of ore deposits in the galleries of the Shibayama mine

they have some relics of a antecedent rock facies, or show a embryos of antenatal rock facies.

Occurrence of ore deposits in the Shibayama mine is illustrated in Fig. 6. The ores develop underground mostly, they are investigated by three galleries. Bonanzas are found in level 1. Ore deposits in this level are divided into several masses by cross or longitudinal faults.

Thus the relations between ores and wall rocks are very complicated.

They could follow the bonanzas only within inclined direction of the ore shoot.

In level 2, ores are hardly found. It is regarded that the gallery is worked beneath the ore horizon along the southern wing of the synclinal axis.

IV. 2 Ore deposit in the Kokuriki mine

Geology and occurrence of ore deposit in the mine are clarified by repeated geologic investigations on surface or underground. The results of the investigations are shown in Fig. 7 and Fig. 8.

Ore deposits develop between chert layer and spilitic lava extending 1,000m in length. Chert layer which played a role of hanging wall is folded strongly and cut by numerous minor faults. Distributions of ore deposits of the mine are controlled by the tectonic movements described above, and they are divided into three blocks. They are called "Maeyama block," "Kanisawa block" and "Okuyama block" from east.

The tectonic in the Maeyama block is characterized by remarkable folding, on the other hand, that of the Okuyama block is characterized by several step faults.

Manganiferous hematite deposits of the mine have been worked by several levels. Several bonanzas are known in the galleries, they show hundred meters both in length and along inclined directions. Bonanzas which occupied in the western area are situated in higher level than those of the eastern area.

Special rock facies such as ferruginous quartz siderite rock develop associated with ores in the mineralized horizon.

The relations between hanging wall and ores in a representative outcrops of the mine are shown in Plate IV, Figs. 7, 8 and the relations between foot wall and ores are given in Plate V, Fig. 11.

IV. 3 Ore deposit in the Nikura mine

The Nikura mine is situated in the uppermost of eastern tributary of the Nikura river, northern part of the mining district. The mine has produced 75,000 metric tons of manganiferous hematite ores which contain 33% of Fe and 10% of Mn during recent ten years.

Geology of the mining area is composed of spilitic pillow lavas, pyroclastic sediments and cherty rocks of Mesozoic era. Distributions of them and their tectonic are shown in Fig. 9, the present authors can find two chert layers, one of them occupied in upper horizon is muddy and the other which plays a role of hanging wall of the ore deposits is more siliceous. Foot wall of the deposits is generally spilitic showing pillow structure. According to microscopic observations, they can distinguish several rock facies such as type-A, type-B and type-C.

Their occurrences are very complicated, then there is no way to distinguish in the geological map. In general, ore deposits develop along the chert layer controlled by basin structure, showing irregular lens form, but sometimes they occur along the fracture system. The representative occurrence of ore controlled by fracture is well known in gallery No. 3, which is illustrated in Fig. 10. In this level, plenty of low grade ore composed

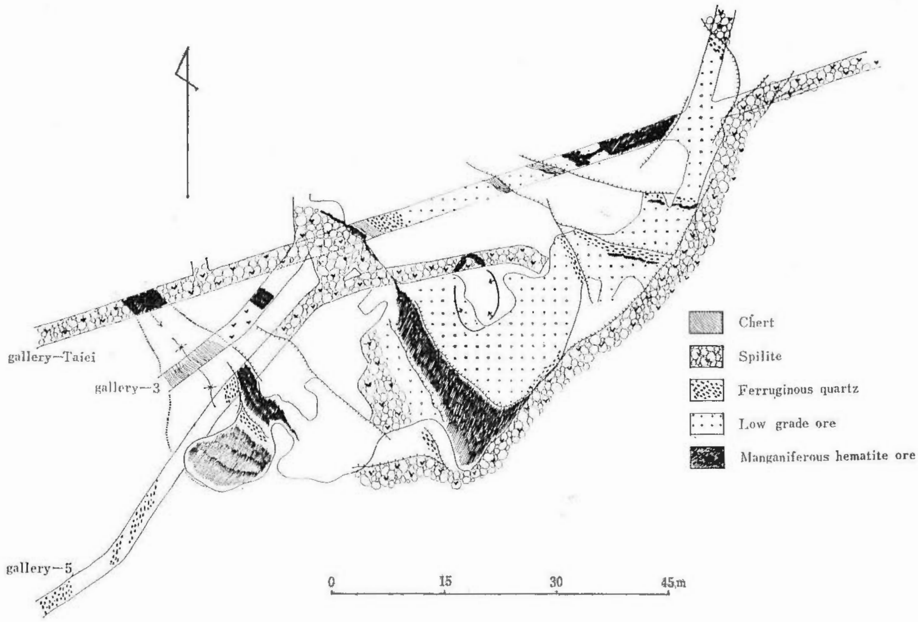


Fig. 10 Occurrence of ore deposits in the galleries of the Nikura mine

of only hematite-I are seen, this ore is very special in the mining district. In this mine, the low grade ores described above are more predominant than dense high grade ore.

IV. 4 Ore deposit in the Hokko mine

The Hokko mine is situated in the northern end of the mineralized zone, facing the sea of Okhotsk.

Geology of the mining area consists of diabasic tuff, chert and mudstone of Mesozoic era. Diabasic tuff is the most predominant among them. Chert layers develop along a synclinal axis showing small basin structure as given in Fig. 11.

In the mining area, the present authors discovered special amphibolite which regarded to be another member of the Hidaka metamorphics. The amphibolite occurs in the eastern part of the area, trending N20°W with 50m in width as "Fenster". Sometimes, fragments of the amphibolite are seen in diabasic tuff. The amphibolite is composed of quartz, plagioclase and soda-amphiboles showing violet green tint in thin section. These recrystalline minerals are observed in very fresh state.

Several ore deposits are known in the mining area. They develop along the synclinal axis running to E-W direction. They are "Tobu deposit", "Asahi deposit", "Hayabusa deposit", "Seibu deposit" and "Tsurukame deposit" from east.

Most of them occur only on surface of the hill and the bonanzas of underground cannot be expected in this area, thus the ore deposits in the area are comparatively small, the chert layers which played a role of hanging wall are often erroded away, thus the ore deposits commonly have not anything to hang over. Consequently the ore deposits in the area often look like a kind of residual deposits.

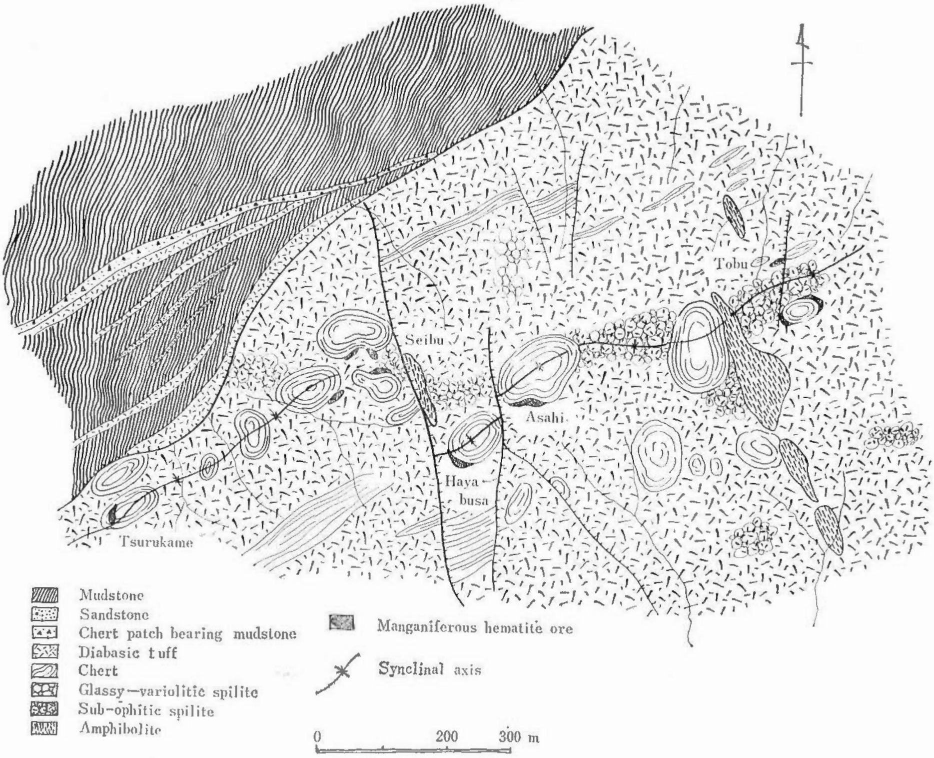


Fig. 11 Geological map of the Hokko mine

IV. 5 Ore deposit in the Poronai mine

The Poronai mine is situated on the eastern side of the Shibayama mine, which was worked since 1961 and produced about 1,500 metric tons of ores containing 31% of Fe and 9% of Mn.

Geology and its tectonics are given in Fig. 12. The geology of the mining area is composed of spilite, diabasic tuff and radioralian chert. Sometimes, diabasic tuff and radioralian chert are alternating to each other showing fine banded structure, which is called " mixed facies " by the present authors. In general, the mixed facies develop showing thin layers in the central part of the area. Spilite and chert develop in northern part and pyroclastic sediments occur in southern part of the area. Geotectonics are characterized by fracture systems trending N-S or N30°E.

Ore deposits of this area are generally controlled by the fracture systems described above. Consequently the form of ore deposit is often lenticular. One of the representative occurrences is given in Plate VI, Fig. 13.

The authors have arrived at a conclusion that the vein type manganiferous hematite deposits may be caused by filling phase after the main mineralization represented by bedded manganiferous hematite deposits.

In the Poronai mine area, we can hardly find the normal bedded type of deposits regarded to be caused by replacement for the ferruginous quartz rock.

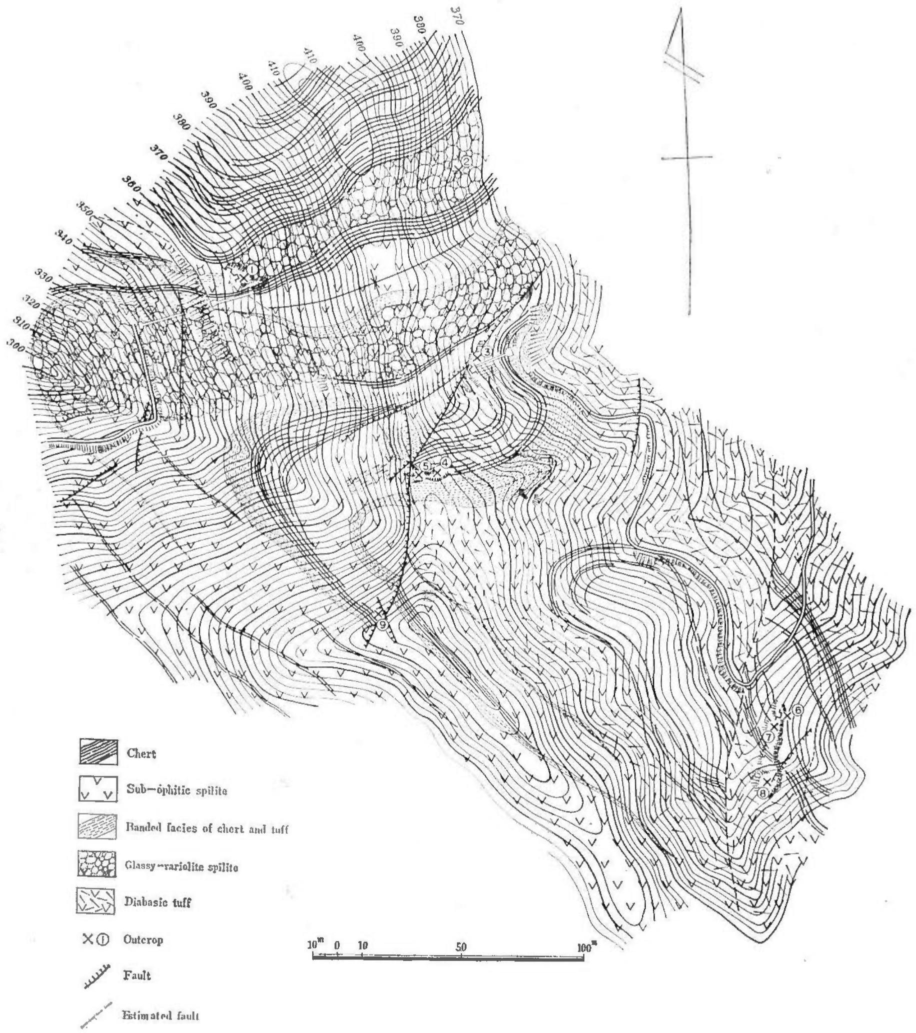


Fig. 12 Geological map of the Poronai mine

IV. 6 Ore deposit in the Fukuyama mine

The Fukuyama mine is located on the eastern side of the Poronai mine. The ore deposit of the mine is the smallest one in this mining district. The mine was worked since 1962 by the Harita Mining Company. Unfortunately, there were no ore in galleries although the outcrop looks like worthy. He produced only 100 metric tons of ore containing about 20% of Fe and 15% of Mn during one year.

Geology of the mining area is composed of spilite, radioralian chert, diabasic tuff and mixed facies of chert and diabasic tuff. The mixed facies develop in the mineralized horizon playing a role of hanging wall or foot wall for the ore bodies. Geotectonic is comparatively simple, showing E-W trend. A few faults running N30°E or N30°W are often observed. Along the faults, slight mylonitic rocks or brecciated rocks are observed.

Outcrops develop in several localities, however they are almost valueless. The most

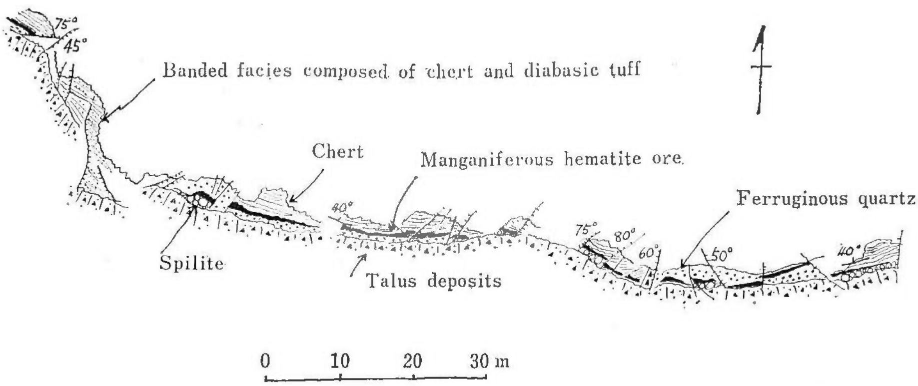


Fig. 13 Occurrence of ore deposits in the Fukuyama mine

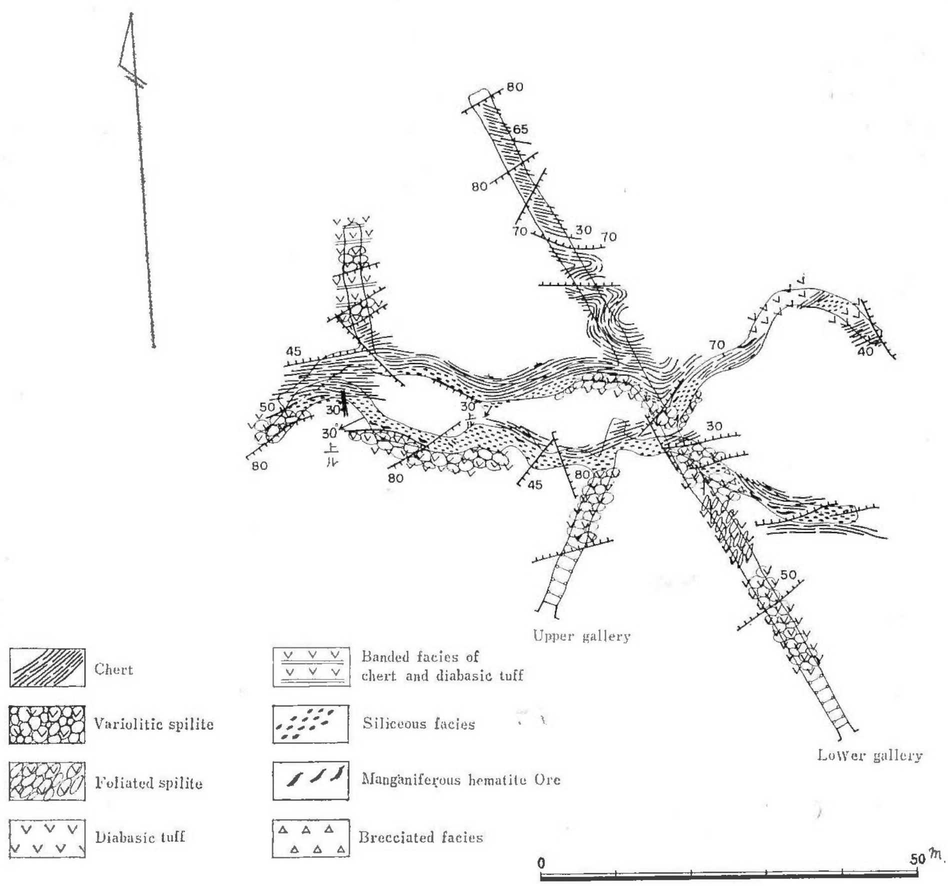


Fig. 14 Underground geology of the Fukuyama mine

expective outcrop of the ore deposits in the area is given in Fig. 13. Two galleries followed the ores, but they could not find any bonanzas. The result of the underground exploration is shown in Fig. 14. Thus the present authors came to a conclusion that the mineralization is incomplete and worthy look exposures are regarded to be brought up by oxidation in the open air.

V. Ores and Ore Minerals

Manganiferous hematite ore from the Tokoro mining district is roughly classified into three types. They are low grade disseminated ore, spotted ore and dense massive ore. The authors want to illustrate the ore textures of them and some characters of ore minerals.

V. 1 Low grade disseminated ore

Strictly speaking, two kinds of low grade disseminated ores are known. One of them is regarded to be caused by recrystallization as a result of metasomatism against the ferruginous quartz rock. Ore texture of this type is illusrated by photo-micrographs given in Plate XIV, Figs. 41, 42 or in Plate XV, Fig. 43.

The other disseminated ore facies is given in Plate XV, Fig. 44, which is regarded to be originated by precipitation phase. The size of hematite crystals in this facies is bigger than that of the former type and there is no indications to explain the metasomatic conditions. However it seems that those two kinds of hematite are formed nearly in the same stage, thus the present authors want to call them " hematite-I " to distinguish from the other hematite groups. It is common that they are modified by penwithite crystals believed to be formed in a later stage. Hematite-I shows strong anisotropism under reflective microscope.

V. 2 Spotted ore and dense massive ore

Spotted ore and dense ore are easily distinguished from each other by their characteristic ore textures. However they are composed of the same ore minerals. Hematite crystals in this facies are so small that it is very difficult to clarify the crystal forms. According to microscopic investigations, both spotted ore and dense ore are composed of aggregates of short prismatic hematite crystals.

Ore texture of spotted ore is given in Plate XV, Fig. 46 and general dense ore is shown in Plate XV, Fig. 45. As shown in the reflective photomicrographs crystal form is very different from the "hematite-I", it is necessary to distinguish the hematite from "hematite-I", thus the present authors want to call it "hematite-II" according to the difference of mineralization stage.

V. 3 Special ore composed of coarse hematite crystals

This type is regarded to be formed in the latest stage of the serial mineralization, because coarse hematite crystals develop showing vein form along the cracks of the ore, sometimes which is accompanied with calcite veins.

Generally, we can distinguish two kinds of hematite in the ore of the latest phase. One is fibrous and show strong anisotropism (Plate XVI, Fig. 47), the other is massive and show steel gray to iron black with brilliant luster. The parting due to polysynthetic twinning is distinct (Plate XVI, Fig. 48). Under the reflective microscope, pleochroism from gray white to pinkish white is observed.

V. 4 Penwithite

As described above, more or less ten percent of manganese are detected in dense ore. Almost of the manganese must be derived from penwithite, because penwithite is very common in all of the ore, and recent mineralogical investigations by Y. SHIMAZAKI clarified that any other manganese minerals had not been known in the ore. On the other hand, microscopically, penwithites occur as vein form or as dust state in hematite ore. The color of penwithite is reddish brown showing strong pleochroism as below:

Z=reddish brown X=light yellow

VI. Genesis of the Ore Deposits

The origin of the manganiferous hematite deposits in the Tokoro mining district has been explained by N. ASAHI (1953), J. SUZUKI (1953), (1956) and A. TAKABATAKE (1955), (1956). They noted that the main ore bodies formed by repeated precipitations of iron in the geosynclinal basin of late Mesozoic period. They noted also that a little amount of iron and manganese were added in the hydrothermal phase. The relation between spilite activities and the mineralization has been illustrated as a kind of sublimations of volcanic activities.

The present authors attempted to suggest the genesis of the deposit from another viewpoint based on tectonics, volcanic activities and related chemical evolutions and so on.

At the beginning, abundant siderite or ferruginous quartz containing a little amount of iron must be accumulated in the geosynclinal basin as a gel state, however it should not yet be realized the important ore bodies. In a later phase of the precipitation or in the diagenesis phase, a part of the ferruginous quartz layer bleached and generated two facies. One is aggregates of hematite-I and the other is white pool composed of general quartz. It is believed that no addition of iron into the layer should be realized in this phase.

In the orogenic phase, the sediments and the spilite lavas folded showing N30°E trend, and in late orogenic stage, in some areas, doming structures associated intrusions of sodaclase-keratophyre or titanaugite bearing diabase formed.

As the result of the orogenic movement, especially according to the tectonic mobilizations, the Mesozoic formations were divided into three blocks by two parallel faults running N-S trend. The strike of the formation of the central block has shown E-W though those of both outer side blocks were characterized by N30°E trend.

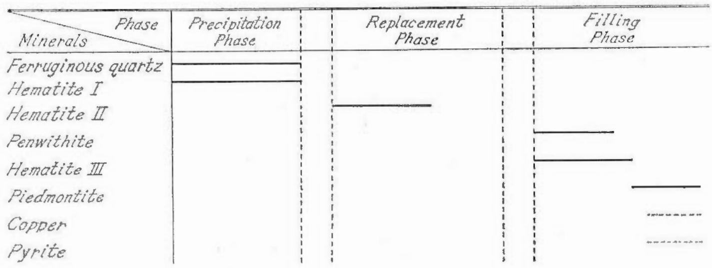
In the central block, the ferruginous quartz siderite layers were replaced by more abundant iron. The replacement might be realized under control of many tension cracks in the ferruginous quartz mass, and irregular lenses of dense ores constructed by hematite-II were found.

As advanced iron metasomatism, considerable amounts of quartz and calcite were squeezed out in the mineralized horizon.

In a post stage of the initial mineralization, coarse hematites and penwithites filled the cracks in the main ore bodies. The coarse hematite is very different from the other two in their properties, thus they are named "hematite-III".

The iron and manganese mineralizations in the Tokoro mining district should be distinguished into three phases as described above. They are not always proceeded in everywhere occupied by spilite. The mineralization seems to be localized controlling by the dome structure caused by intrusions of sodaclase-keratophyre or the other alkalic rocks.

Table 5 Mineral sequence of the manganiferous hematite deposits in the Tokoro mining district, Hokkaido, Japan



Acknowledgements

This problem in Japan has been initiated by Dr. Jun SUZUKI, M. J. A..

Petrographic significance of spilite and its classification in this paper were owed very much by the valuable guidance from him.

During the investigations in the Tokoro mining field, the authors were assisted by Mr. MATSUMURA, chief geologist of the Kokuriki mine. Drs. A. TAKABATAKE, M. SAITO, Y. SHIMAZAKI and E. NARITA, members of Geological Survey of Japan, cooperated with us and provided many helpful suggestions in field and laboratories.

The present authors want to express their thanks to those persons noted above.

References

ASAHI, N. & SAITO, M. (1953) : Report on manganiferous hematite deposits in the Tokoro district, Hokkaido, Japan. Hokkaido Chikashigen Chosashiryo, no. 8.

BAMBA T. & MATSUMURA, A. (1962) : Report on manganiferous hematite deposits surrounding the Saroma lake, Kitami province, Hokkaido, Japan. Hokkaido Chikashigen Chosashiryo, no. 72.

BAMBA, T. (1963) : Manganiferous iron ore deposits in the Tokoro district, Hokkaido, Japan. Bull. Geol. Surv. Japan, vol. 14, no. 3.

BAMBA, T. (1964) : Manganiferous hematite deposits of the Fukuyama and Poronai mines in the Tokoro district, Kitami province, Hokkaido, Japan. Hokkaido Chikashigen Chosashiryo, no. 91.

BARTRUM, J. A. (1936) : Spilitic rocks in New Zealand. Geol. Mag. 123.

HOPGOOD, A. M. (1962) : Redial distribution of soda in a pillow lava of spilitic lava from the Franciscan, California. Am. Jour. Sci., vol. 260, p. 383–396.

JOHANNSEN, A. (1937) : A descriptive petrography of the igneous rocks, vol. 3.

LIDIAK, E. G. (1965) : Petrology of andesitic, spilitic and keratophyric flow rock, North-central PuertoRico. Geol. Soc. America Bull., vol. 76, no. 1.

PETER, H. G. (1961) : Zur Spilitbildung. Geol. Rundschau, vol. 51, no. 2.

SUZUKI, J. & OHMACHI, H. (1953) : A study of manganiferous iron ore from the Tokoro district, Hokkaido, Japan. Jour. Geol. Soc. Japan, vol. 59.

SUZUKI, J. (1954) : Pillow lavas from Hokkaido, Japan. Bull. Geol. Comm. Hokkaido, no. 26.

SUZUKI, J. (1955) : On some petrological problems of diabase. Bull. Geol. Comm. Hokkaido, no. 30.

SUZUKI, J. & OHMACHI, H. (1956) : Manganiferous iron ore deposits in the Tokoro district, Hokkaido, Japan. XXth International Geol. Congress in Mexico.

TAKABATAKE, A. (1955) : Genesis of manganiferous iron deposits in Japan. Jour, Soc. Mining Geologist, Japan, vol. 7, no. 24.

TAKABATAKE, A. (1956) : Genesis of manganiferous iron deposits in Japan. XXth International Geol. Congress in Mexico.

TAKABATAKE, A. (1958) : On the manganiferous iron ore of Japan. Jubilee Publ. in the Commemoration of Prof. Jun SUZUKI, M. J. A. Sixtieth Birthday.

WATANABE, T. (1957) : Genesis of bedded manganese deposits and cupriferous pyrite deposits in Japan. Jour. Soc. Mining Geologist, Japan, vol. 7, no. 24.

(December 28th, 1966 in Sapporo)

北海道常呂地方のスピライトと含マンガン赤鉄鉱鉱床

番場 猛夫・沢　俊明

要　旨

含マンガン赤鉄鉱鉱床は含銅硫化鉄鉱鉱床と同じように，地向斜帯に賦存する層状鉱床で，その成因が"syngenetic"かあるいは"epigenetic"かと論議されている。われわれは上記の点に興味をもち，鉱化帯の地質構造上の位置づけ，鉱床母岩をなすチャート・スピライトの岩石学的検討および鉱床と同一層準に発達する鉄石英岩にみとめられる相変化などを重点的にとりあげ，含マンガン赤鉄鉱鉱床の成因究明に寄与しようと試みた。

その結果，本鉱床は地向斜期にスピライトの噴出に関連して沈殿したとみられる鉄石英岩が造山期にあらたに添加された Fe によって1部交代・濃集され，鉄の層状鉱床を形成し，造山末期（断裂期ともいう）に少量の Mn がペンウィサイト，紅簾石として鉱床を修飾したものと考察した。

もとより本研究は終ったわけではなく，将来，含銅硫化鉄鉱鉱床および酸化マンガン鉱床などとの対比を行なう予定であるので，本論はいわば予報ともいうべきものである。

PLATES

AND

EXPLANATIONS

(with 17 Plates)

Fig. 1 Typical scenery on the southern part of mining fields. View looking the Shibayama mine hill from the Kokuriki mine.

Fig. 2 Eastern edge of the Kokuriki mine hill, and the residential quarter of the mine.

Fig. 1

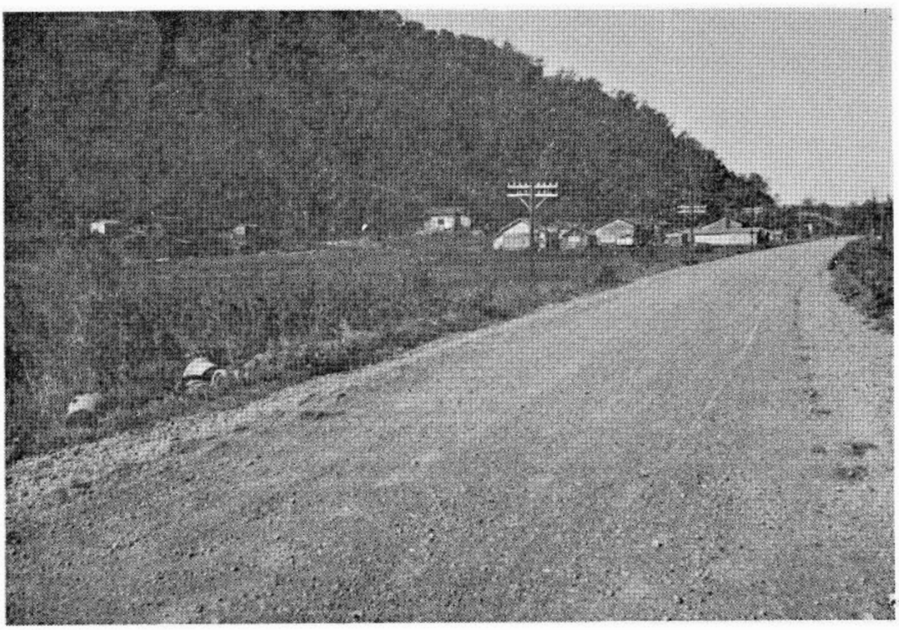


Fig. 2

Fig. 3 Shows one of the earliest prospecting pit of the Kokuriki mine. Cavity on the hill is composed of chert (right hand) and underlying spilite (left hand). At the contact between them, bedded manganiferous hematite deposit develops.

Fig. 4 Dark (chocolate) fragments on a right hand of the inclined shoot are manganiferous hematite ores.

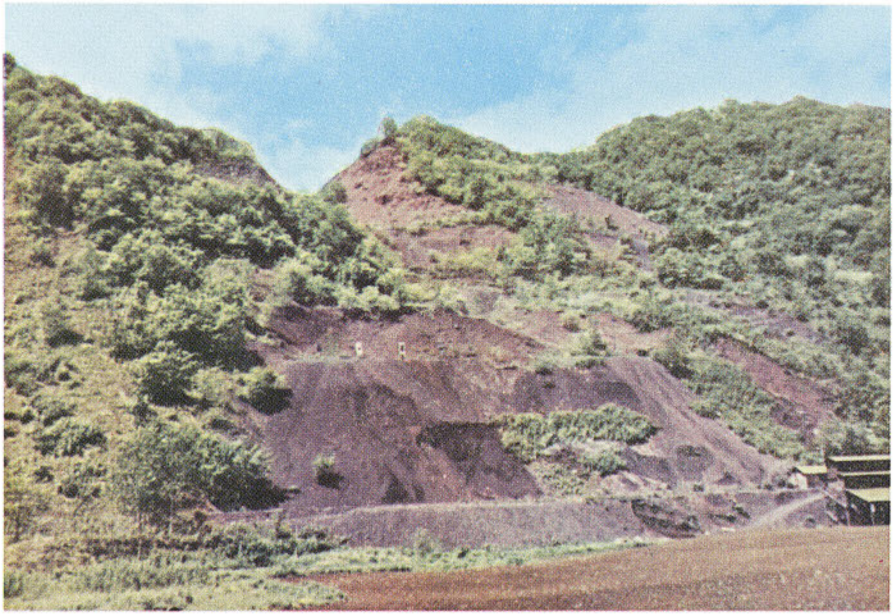


Fig. 3

Fig. 4

Figs. 5, 6 Occurrence of spilite (pillow lava form) in the Kokuriki mine. On the rock properties of marginal part of a pillow and that of the core of the pillow, no differences are found.

Fig. 5

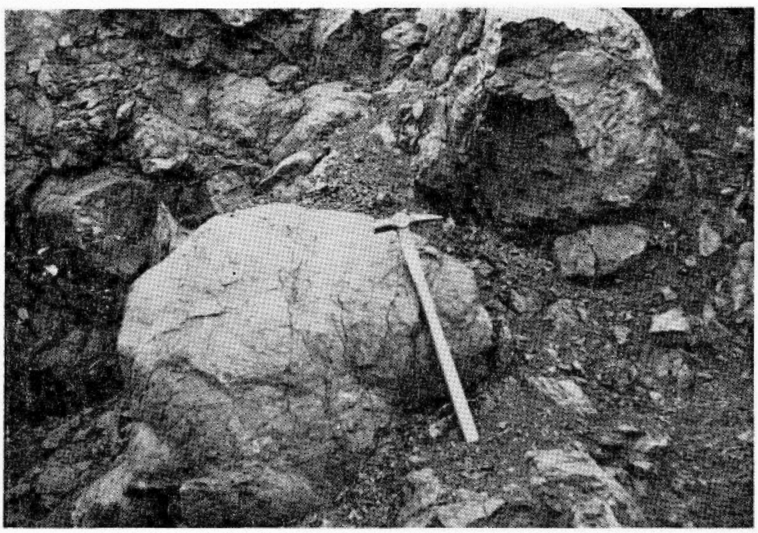


Fig. 6

Fig. 7 General exposure of chert in the Kokuriki mine.

Fig. 8 The contact between manganiferous hematite ore and overlying chert in the Kokuriki mine.

Fig. 9 Ditto, in the Fukuyama mine.

Fig. 10 The contact between manganiferous hematite ore and underlying footwall spilite, in the Fukuyama mine.

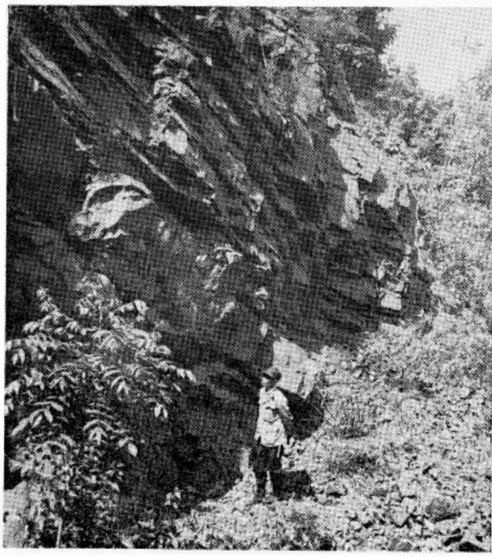


Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11 The contact between manganiferous hematite ore and underlying footwall spilite. Along the contact zone, carbonate aggregates develop. Underground of the Kokuriki mine.

Fig. 12 Spilite showing pillow structure in the Fukuyama mine.

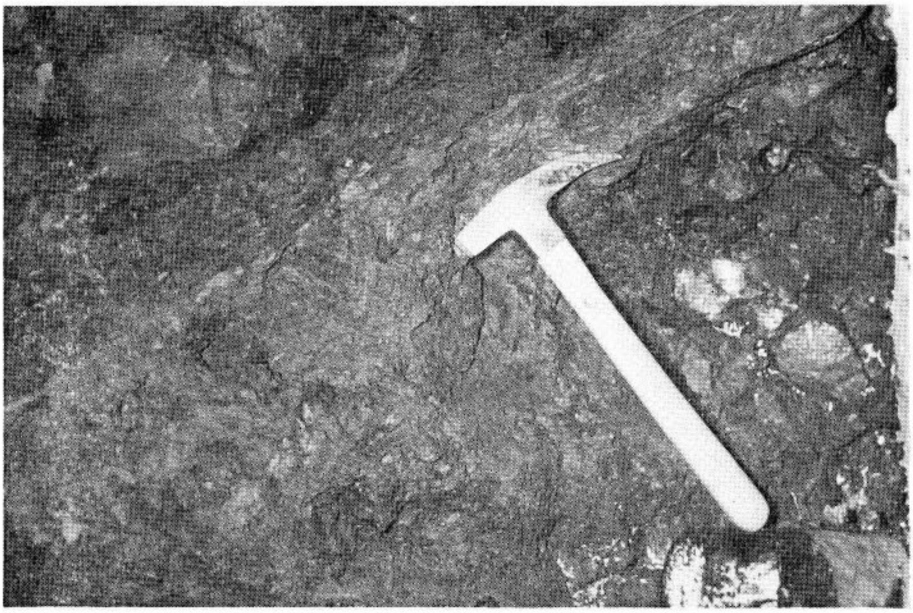


Fig. 11

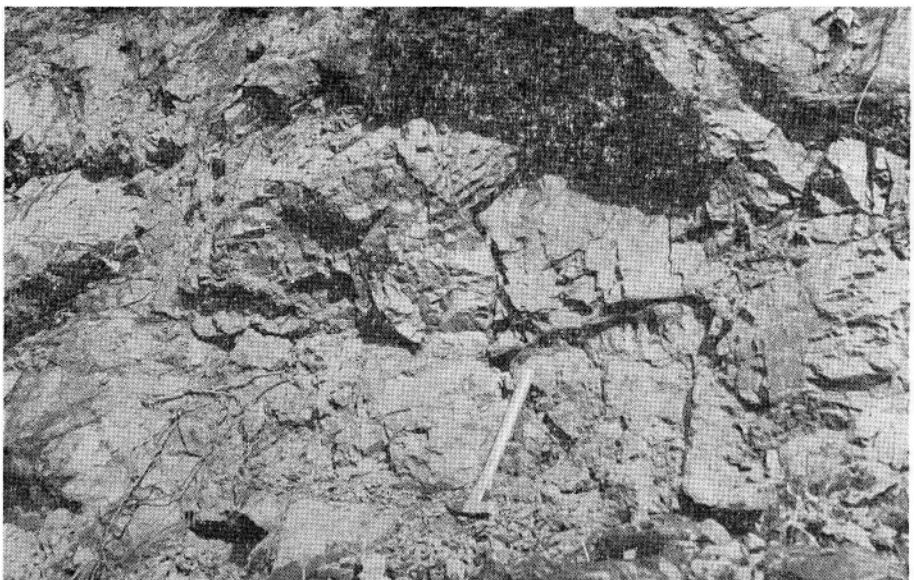


Fig. 12

Fig. 13 Special occurrence of manganiferous hematite deposit,cutting chert formation in the Poronai mine, southern part of the mining district.

Fig. 13

Fig. 14 Characteristic occurrence of manganiferous hematite deposit.
1) Overlying hanging wall(chert).
2) Ore showing minor joints.

Fig. 15 Relict of germinal formation (white) in manganiferous hematite ore, underground of the Fukuyama mine.

Figs. 16, 17 So-called silica stones in the Tokoro mining district.
Black: Red chert or ferruginous quartz
White: Quartz

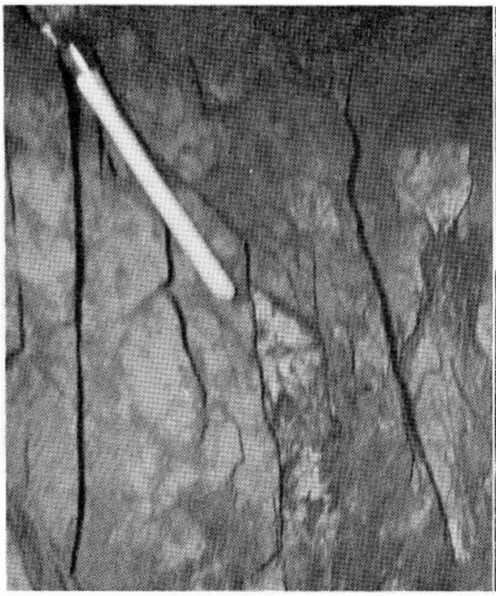


Fig. 14

Fig. 15

Fig. 16

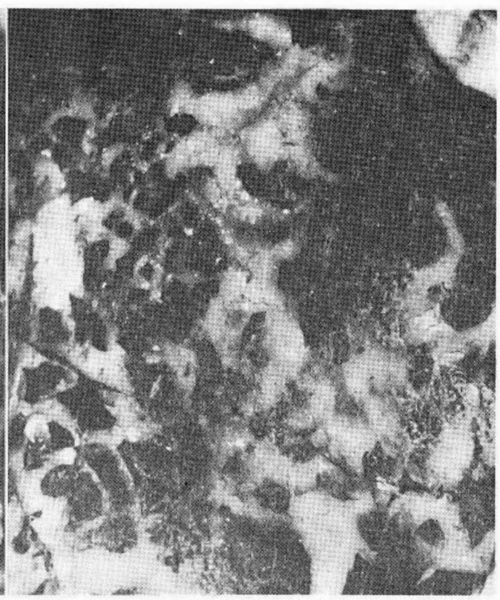


Fig. 17

Spilitic rock series in the Kokuriki mine area, central part of the mining district.
(Photo-micrographs of thin sections)

Fig. 18 Composed of glassy material. ×50

Fig. 19 Sub-ophitic texture by diopsidic pyroxene and plagioclase occurs in variolite. ×50

Fig. 20 Sub-ophitic texture by diopsidic pyroxene and plagioclase. ×50

Fig. 21 Ophitic texture by common augite, plagioclase and ilmenite. ×50

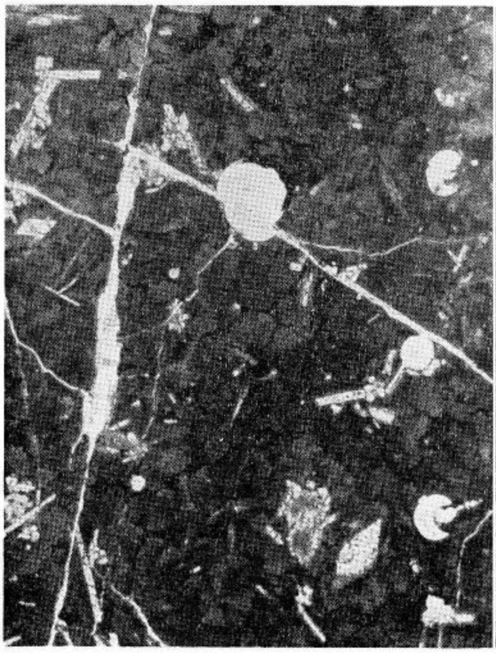


Fig. 18

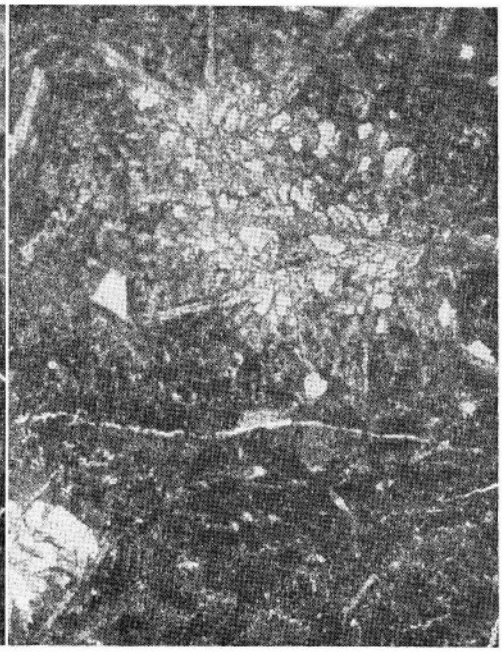


Fig. 19

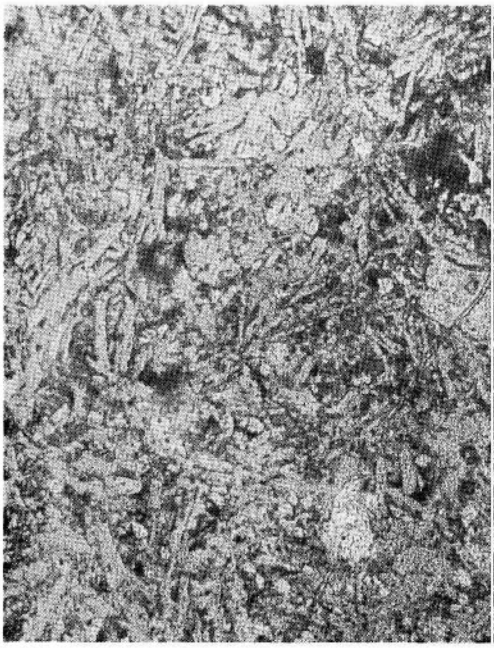


Fig. 20

Fig. 21

Fig. 22

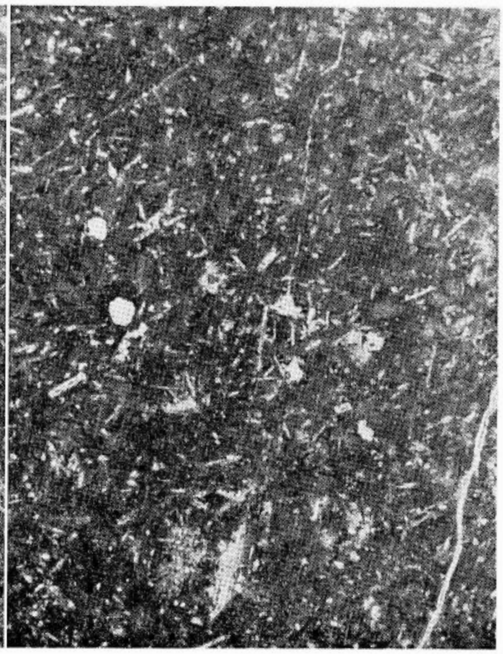


Fig. 23

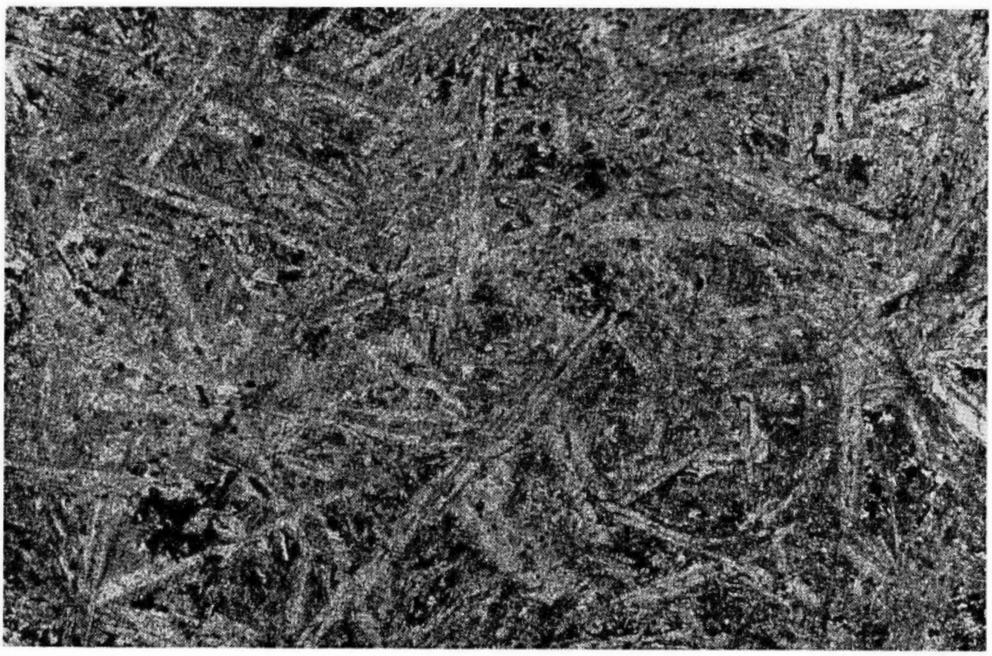


Fig. 24

Spilitic rock series in the Kokuriki mine area, central part of the mining district.
(Photo-micrographs of thin sections)

Fig. 25 Tortoise shell structure composed of glassy material, which is regarded to be an embryo of the variolite texture. ×50

Fig. 26 Variolite texture by plagioclase and glass. ×50

Fig. 27 Sub-ophitic texture by plagioclase and diopsidic pyroxene. Sphene and small amount of ilmenite are associated. ×50

Fig. 28 Sub-ophitic texture by more coarse plagioclase, pyroxene and ilmenite. ×50

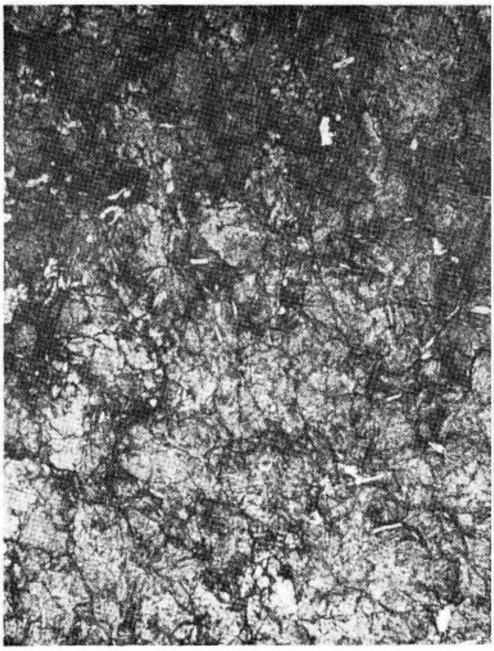


Fig. 25

Fig. 26

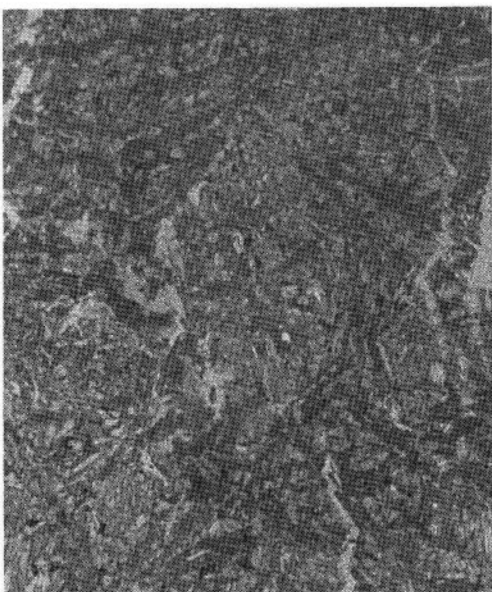


Fig. 27

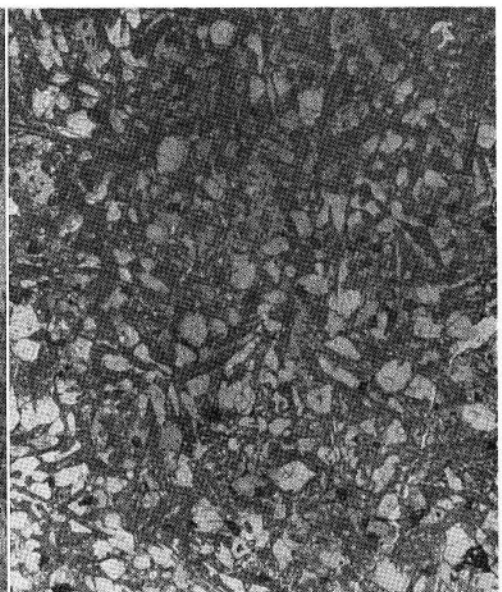


Fig. 28

Spilitic rock series of the Shibayama mine area, southern end of the mining district.
(Photo-micrographs of thin sections)

Figs. 29, 30 Typical variolite composed of plagioclase and glass. ×50

Fig. 31 Porphyritic spilite, ground mass is variolite and phenocryst is sericitized plagioclase. ×50

Fig. 32 Coarse sub-ophitic spilite composed of plagioclase, chlorite and ilmenite. ×50

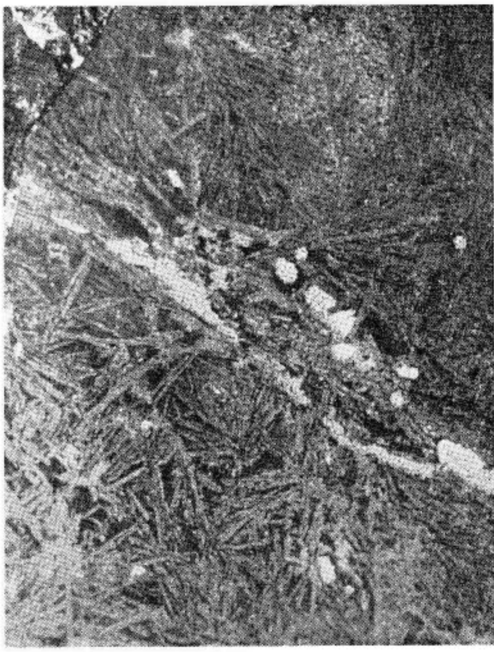


Fig. 29

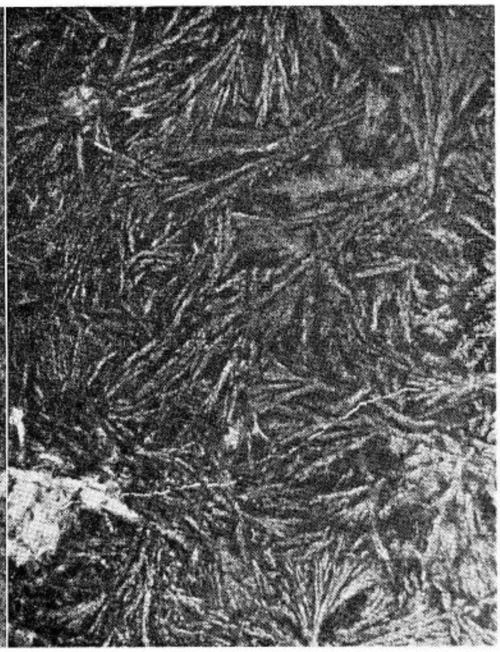


Fig. 30

Fig. 31

Fig. 32

Fig. 33 Microphotograph of coarse sub-ophitic diabase composed of titanaugite, plagioclase and ilmenite in the Tomioka area of the Tokoro mining district. This facies are regarded to be the latest product of the spilitic rock series. ×50

Fig. 34 Microphotograph of keratophyric rock of the Toyokawa area, composed of plagioclase and a small amount of chlorite derived from amphibole. ×50 under crossed nicols.

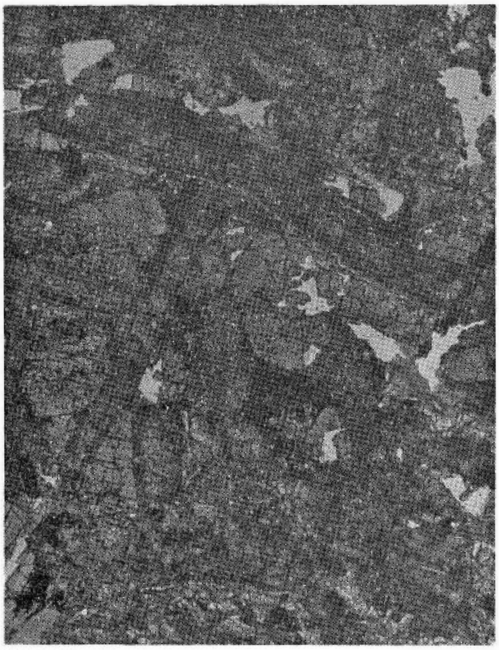


Fig. 33

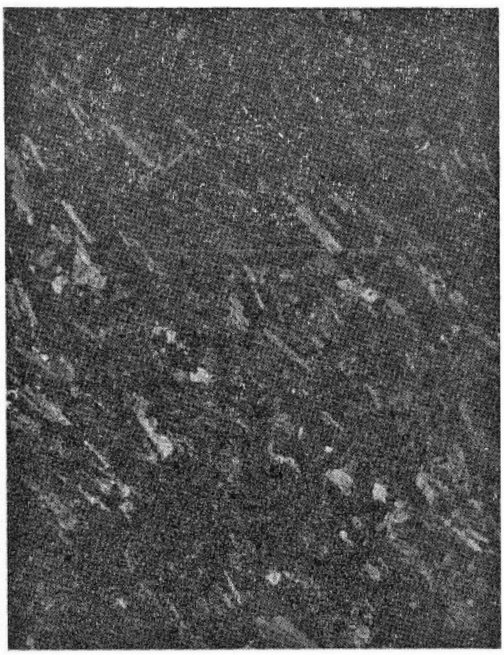


Fig. 34

Fig. 35 Microphotograph of red chert in the Shibayama mine, including plenty of radiolarias. ×50

Fig. 36 Microphotograph showing piedmontite quartz rock in the ore of the Shibayama mine. ×50

Fig. 37 Microphotograph of disseminated hematite ore in the Nikura mine. ×50

Fig. 38 Microphotograph of dense hematite ore in the Fukuyama mine associated with penwithite veins. ×50

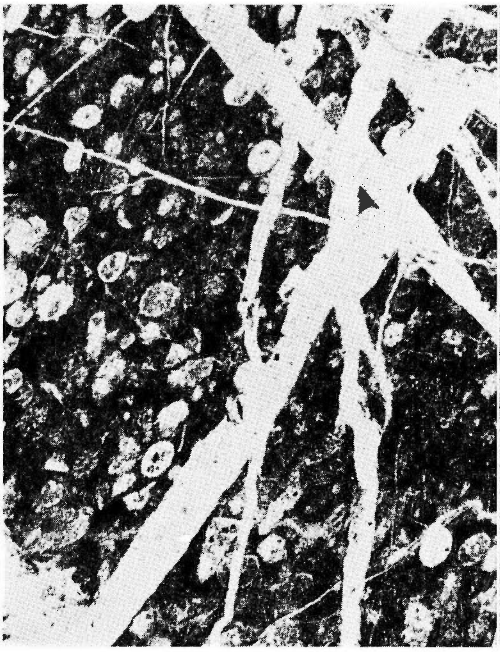


Fig. 35


Fig. 36

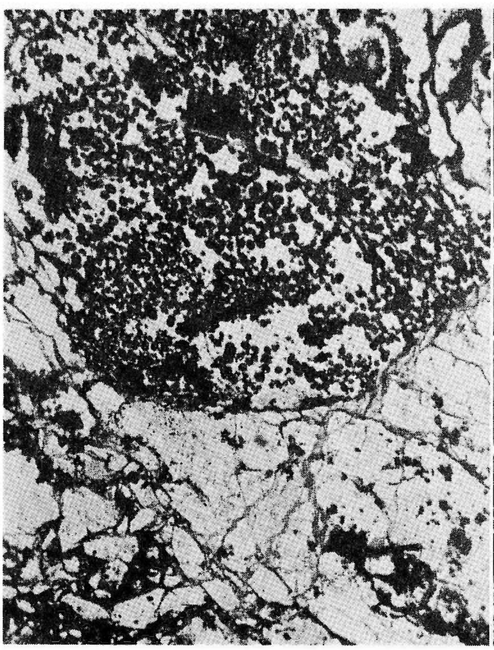


Fig. 37

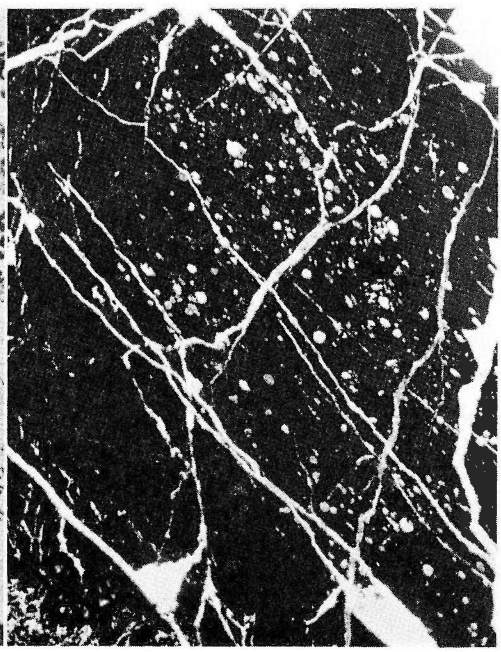


Fig. 38

Ferruginous quartz-siderite rock series in the Kokuriki mine.
(Photo-micrographs of thin sections)

Fig. 39 Ferruginous quartz and hematite-I. (open nicol) ×50

Fig. 40 Siderite-ferruginous quartz (under crossed nicols) ×50

Figs. 41, 42 Ore pigment in the ferruginous quartz has been removed, thus hematite-II has been formed. ×50

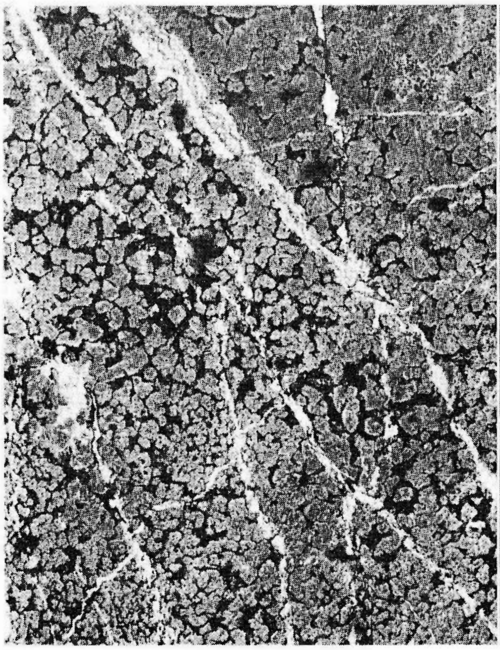


Fig. 39

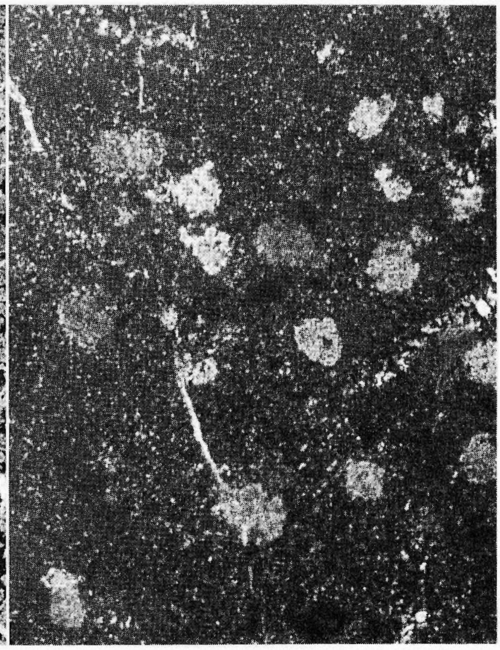


Fig. 40

Fig. 41

Fig. 42

Reflective photo-micrographs on hematite ores in the Tokoro mining district.

Fig. 43 Low grade ore from the Nikura mine. White needles are hematite-I. ×200

Fig. 44 Low grade ore from the Kokuriki mine. White hexagons are hematite-I. ×200

Fig. 45 General dense ore from the Shibayama mine. White aggregates are hematite-II. ×200

Fig. 46 Spotted ore from the Shibayama mine. White spots are composed of hematite-II. ×200

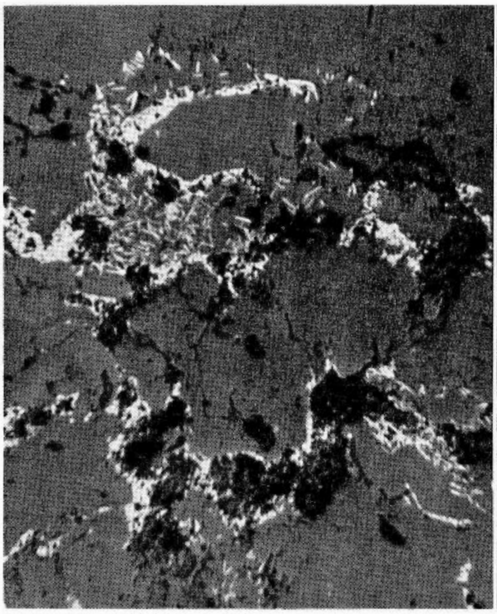


Fig. 43

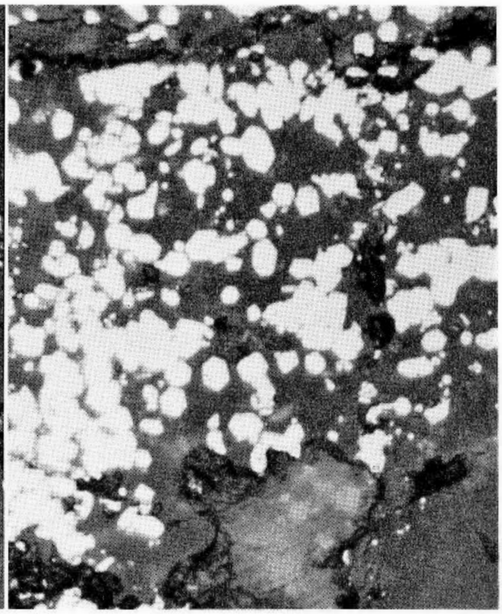


Fig. 44

Fig. 45

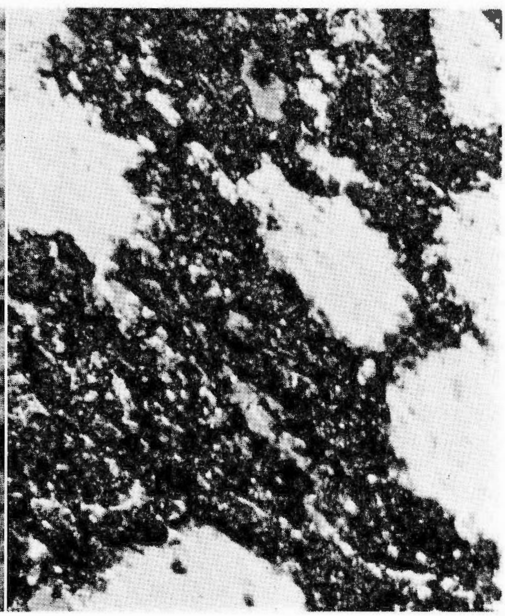


Fig. 46

Reflective photo-micrographs for special ores in the Tokoro mining district.

Fig. 47 Hematite vein associated with calcite vein. White vein or white ring is composed of fibrous hematites, which show strong anisotropism. We want to call them "hematite-III α". (from the Shibayama mine) ×600

Fig. 48 Hematite vein in the low grade ore. Coarse crystals of hematite given in the right hand show very strong anisotropism. Reflective pleochroism changes from gray-white to pinkish white. Which is regarded to be formed in the latest stage of the mineralization. We want to call them "hematite-III β" ×600

Fig. 47

Fig. 48

Reflective photo-micrographs on the manganese ore of the Wakasa mine in the Tokoro metallogenic province.

Fig. 49 Low grade ore regarded to be caused by chemical precipitation in syngenetic stage. We want to correspond it to hematite-I in the Nikura mine at the viewpoint of mineralization phase. ×200

Figs. 50, 51 Dense ore regarded to be caused by replacement in a later stage of the manganese mineralization. ×200

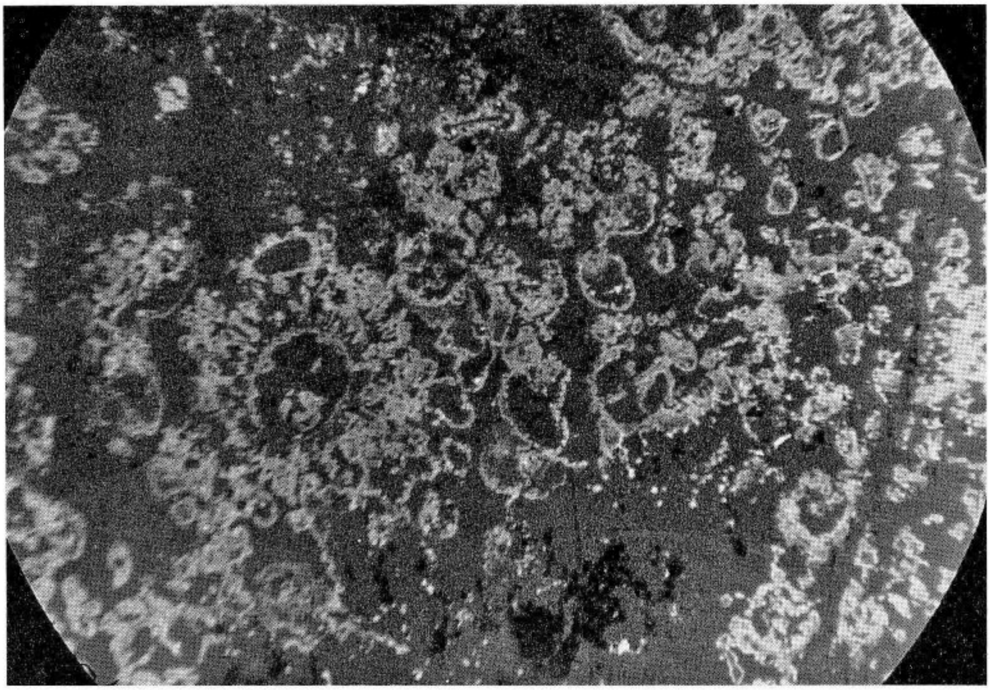


Fig. 49

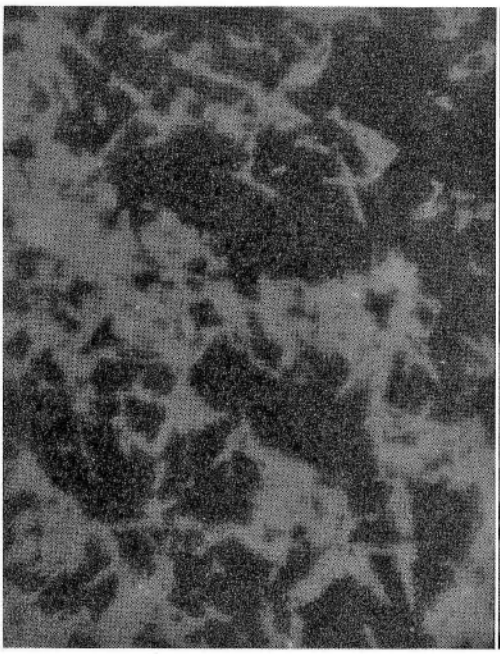


Fig. 50

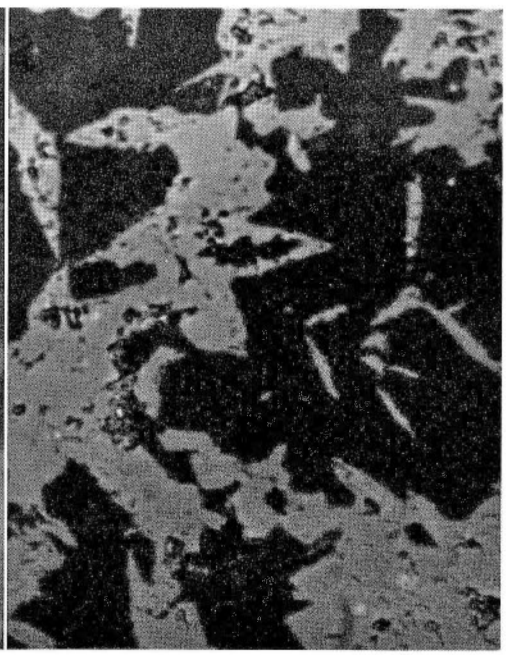


Fig. 51

地質調査所報告は１報文について報告１冊を原則とし，その分類の便宜のために，次のようにアルファベットによる略号をつける。

A．地質およびその基礎科学に関するもの
- a．地　質
- b．岩石・鉱物
- c．古生物
- d．火山・温泉
- e．地球物理
- f．地球化学

B．応用地質に関するもの
- a．鉱　床
- b．石　炭
- c．石油・天然ガス
- d．地下水
- e．農林地質・土木地質
- f．物理探鉱・化学探鉱および試錐

C．そ の 他

D．事業報告

As a general rule, each issue of the Report, Geological Survey of Japan will have one number, and for convenience's sake, the following classification according to the field of interest will be indicated on each Report.

A. Geological & allied sciences
- a. Geology
- b. Petrology and Mineralogy
- c. Paleontology
- d. Volcanology and Hot spring
- e. Geophysics
- f. Geochemistry

B. Applied geology
- a. Ore deposits
- b. Coal
- c. Petroleum and Natural gas
- d. Underground water
- e. Agricultural geology and Engineering geology
- f. Physical prospecting, Chemical prospecting & Boring

C. Miscellaneous

D. Annual Report of Progress

地質調査所報告

第 216 号

小西泰次郎：秋田県横手盆地の水理地質学的研究，1966

第 217 号

KURASAWA, H.: Petrology of the Kita-matsuura basalts in the northwest Kyushu, Southwest Japan, 1967

第 218 号

ISHIHARA. S.: Molybdenum mineralization at Questa Mine, New Mexico, U. S. A., 1967

第 219 号

高橋　稠：地下水地域調査にみられる水温の総括的研究，1967

第 220 号

斉藤正雄：北海道の鉄資源，1967

REPORT, GEOLOGICAL SURVEY OF JAPAN

No. 216

KONISHI T.: Hydrogeological study of the Yokote basin, Akita prefecture, 1966 (in Japanese with English abstract)

No. 217

KURASAWA, H.: Petrology of the Kita-matsuura basalts in the northwest Kyushu, Southwest Japan, 1967 (in English)

No. 218

ISHIHARA, S.: Molybdenum mineralization at Questa Mine, New Mexico, U. S. A., 1967 (in English)

No. 219

TAKAHASHI, S.: On the ground-water temperature in Japan, 1967 (in Japanese with English abstract)

No. 220

SAITO, M.: On the iron resources of Hokkaido, Japan, 1967 (in Japanese with English abstract)

Bamba, T.
Sawa, T.

Spilite and Associated Manganiferous Hematite Deposits of the Tokoro District, Hokkaido, Japan.

Takeo, BAMBA & Toshiaki, SAWA

地質調査所報告, No. 221, p. 1~21, 1967
14 illus., 17 pl., 5 tab.

The origin of these deposits has been illustrated by two different viewpoints. They are theory of syngenetic mineralization and that of epigenetic one. The present authors have a great interest on a relation between spilite activities and associated iron deposits relating to their genesis.

As the results of investigations, they came to a conclusion that the deposits could be realized by replacement of iron against the ferruginous quartz rock caused by exhalative precipitations in deuteric phase of spilite activities. Manganese are regarded to be added as penwithite in the latest stage of the serial mineralization.

552.3+553.31(524)

昭和42年10月 2 日　印刷
昭和42年10月 7 日　発行

工業技術院地質調査所

印刷者　坂　根　謙　吉
印刷所　株式会社坂根商店

地 質 調 報
Rept. Geol. Surv. J.
No. 221, 1967