Neogene mineralization in the Kunitomi-Jozankei-Chitose area, Hokkaido, Japan

—with special reference to tectonical setting of the ore deposits—

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Abstract : Most of the Kunitomi-Jozankei-Chitose area is occupied by the Neogene Tertiary system and the Pleistocene series which consist mostly of pyroclactic rocks. They are divided into the Jozankei group of Early Miocene in age, the Furubira Group of ranging from the Middle Miocene to the Late Miocene, the Kucchan Group and the Toyama Group in the Late Miocene, the Nishino Formation of the Pliocene and andesite lava and welded tuff of the Pleistocene.

As volcanic activities after the Early Miocene can be traced at different sites in each sedimentary formation, a tectonic evolution of this area can be reconstructed, on the basis of the shift of sites of the volcanic activity. Thus, this area divided into three tectonic units by the rock facies of the Furubira Group: the Kunitomi unit and the Jozankei unit in which volcanic activities were frequent, and the Yoichi-Kucchan unit in which volcanic activity is less though clastic sediments are prominent.

Many ore deposits of Kuroko, vein type and others occur in this area. Based on the stratigraphy of country rocks, and the K-Ar age of sericitized rocks resulted from the ore mineralization and adularia in the gangue minerals, the mineralization is divided into three stages; the first stage being at deposition of the Furubira Group in Middle Miocene in age, the second stage of the later deposition of the Furubira Group in the late Middle to early Late Miocene, and then the third stage.

The ore deposits of the first mineralized stage are of the typical kuroko which occurred in the area where felsic volcanic rock is prominent around the center of the Kunitomi and the Jozankei units. The ore deposits of the second mineralized stage are of kuroko types with some deposits of vein types in the sites where andesitic volcanic activities took place on the periphery of the Jozankei unit. The ore deposits of the third mineralized stage which are composed of vein type were formed in the middle of the Kunitomi and the Jozankei units, where the uplift was prominent since the Middle Miocene and at the locally uplifted part on the periphery of the Jozankei unit.

INTRODUCTION

The Kunitomi-Jozankei-Chitose area (Fig. 1) is in the southwestern Hokkaido Green Tuff Area, which is regarded as to be a northern extension of the Inner Zone of northeastern Honshu. This area has a wide distribution of the Neogene Tertiary strata mainly comprised

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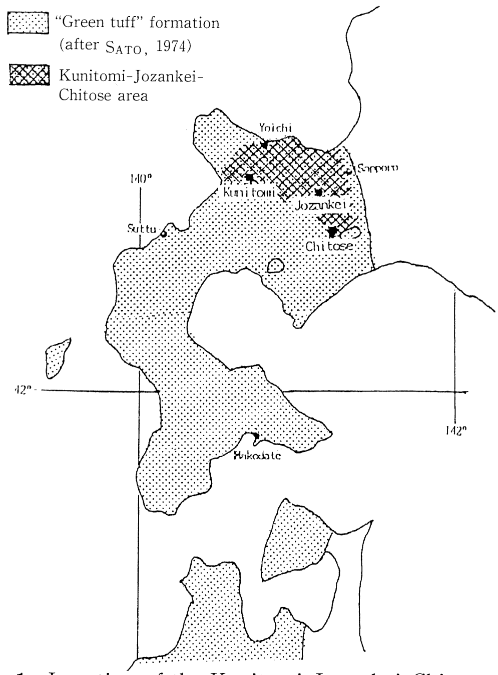


Fig. 1 Location of the Kunitomi-Jozankei-Chitose area.

of pyroclastic rocks. Many types of ore deposits including kurokos, vein types and others are found in these strata. The facts that the types are diverse and that a large amount of metal products is mined, made it as one of famous mining areas in Hokkaido.

HASEGAWA and OSANAI (1978) discribed the geology, tectonics and tectonic evolution of the Kunitomi-Jozankei area based on the field geology of the Kunitomi and the Jozankei (MITI, 1969-1974. etc.). Following their work, geological studies had been carried out over the Chitose area, southeast of the Kunitomi-Jozankei Area (MITI, 1979, HASEGAWA et al., 1981, 1987). These studies revealed that the same tectonics taken place in the Jozankei area are continuously maintained through the Chitose area. Thus, it is more comprehensive to discuss the tectonics around Jozankei by combining the Kunitomi-Jozankei and the Chitose areas into one.

As for the period of formation of the ore deposits except for that of the kuroko deposits, it has been believed to be a late stage of the Miocene, judging from their country rocks. However, considering the recent works on the dating of the sericitized rocks and adularia related to the mineralization, now requires the revision of the mineralized stage of the ore deposits. Thus, the author attempted to document the characteristics of the sites where ore deposits were formed at each mineralized stage following the tectonic evolution of this area.

I GEOLOGY

Since the Neogene Tertiary stratigraphy, the tectonics and its evolution in the Kunitomi-Jozankei area were repoted by HASEGAWA and OSANAI (1978), those studies have been extended to cover the area down as far as the Chitose area.

1. Stratigraphy

The Neogene Tertiary system that unconformably covers the basement rocks is divided, in ascending order, into the Jozankei, the Furubira, the Kucchan and the Toyama Groups of the Miocene, and the Nishino Formation of the Pliocene. Brief geologic and petrologic character of these groups will be described following, but among them, the Furubira Group will be described dividing further into four formations in this paper. The Quatarnary is composed of andesite lavas, welded tuffs and alluvial deposits (Table 1, Fig. 2).

1.1 Basement rocks

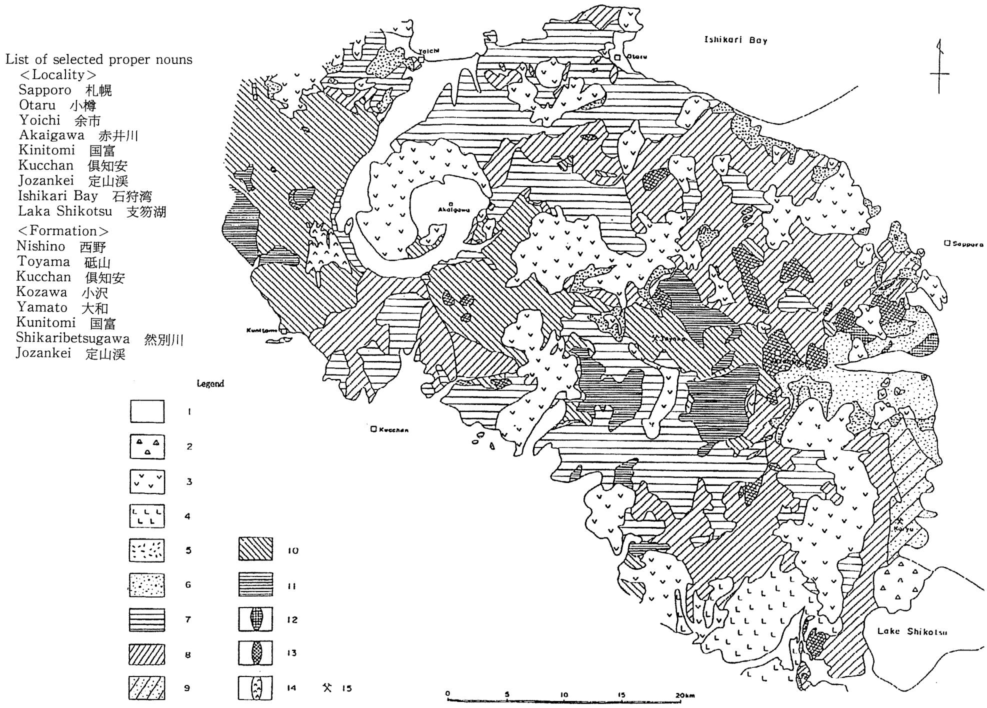
The basement rocks which are mainly composed of alternating beds of sandstone and slate with granodiorite intrusion, are only partially exposed.

1.2 Miocene series

1) Jozankei Group … Most of this group are mainly composed of andesite lavas and pyroclas-

Table 1 Stratigraphical sequence.

(Ma) Age				Formation		Main rock facies	
	Quaternary Plistocene					andesite lava•welded tuff	
5	Neogene Tertiary	Pliocene		Nishino F.		andesite-dacite lava & pyroclastic rocks	
	Neogene Tertiary	Miocene	Late	Kucchan G.	Toyama G.	andesite lava & pyroclastic rocks sandstone•mudstone	conglomerate•mudstone•sandstone
10	Neogene Tertiary	Miocene	Late / Middle	Furubira G.	Kozawa F.	rhyolite lava & pyroclastic rocks•andesite lava & pyroclastic rocks	
	Neogene Tertiary	Miocene	Middle	Furubira G.	Yamato F.	andesite lava & pyroclastic rocks•basalt lava•mudstone	
	Neogene Tertiary	Miocene	Middle	Furubira G.	Kunitomi F.	dacite-rhyolite lava & pyroclastic rocks basalt lava mudstone	
15	Neogene Tertiary	Miocene	Middle	Furubira G.	Shikaribetsu gawa F.	andesite lava & pyroclastic rocks•dacite lava & pyroclastic rocks conglomerate•mudstone	
	Neogene Tertiary	Miocene	Early	Jozankei G.		rhyolite lava & pyroclastic rocks andesite lava & pyroclastic rocks	
				Basement rocks		sandstone•mudstone•granodiorite	



1 : Alluvial deposits, 2 : Andesite lava (Holocene), 3 : Andesite lava (Pleistocene), 4 : Welded tuff (Pleistocene), 5 : Nishino formation, 6 : Toyama group, 7 : Kucchan group, 8 : Kozawa formation and Yamato formation, 9 : Mudstone prominent facies of Yamato formation, 10 : Kunitomi formation and Shikaribetsugawa formation, 11 : Jozankei group and Basement rocks, 12-14 : Intrisive rocks (12 : Dacite(C), 13 : Dacite(A•B), quartz porphyry and granitic rocks, 14 : Basalt) 15 : Working mine

Fig. 2 Geological map of the Kunitomi-Jozankei-Chitose area.

tic rocks, and its upper part consists of rhyolite, welded tuff, mudstone and sandstone.

2) Furubira Group ··· This group, unconformably covering the Jozankei Group, consists of the Shikaribetsugawa, the Kunitomi, the Yamato and the Kozawa Formations in ascending order.

Shikaribetsugawa Formation : The lower part is composed of conglomerate, sandstone, mudstone and tuff, and the upper part consists of dacite lavas, andesite lavas and their pyroclastic rocks.

Kunitomi Formation : The Kunitomi Formation is partly conformable and partly unconformable with the Shikaribetsugawa Formation. Most of this formation are composed of rhyolite-dacite lavas and their pyroclastic rocks, and the upper part consists of basalt lavas and mudstone.

Yamato Formation : This formation is conformable with the Kunitomi Formation. It is mainly composed of andesite lavas and pyroclastic rocks intercalating with mudstone and sandstone. At the north of Lake Shikotsu, andesitic pyroclastic rocks overlay a thick bed of mudstone which is included in the Yamato Formation (ISHIDA et al., 1980).

Kozawa Formation : This formation is conformable with the Yamato Formation, except for the north part of the Toyoha mine. In the west of Jozankei it is mostly composed of rhyolite lavas and pyroclastic rocks. Around Jozankei it is composed of dacitic pyroclastic rocks, andesite lavas and its pyroclastic rocks.

3) Kucchan Group and Toyama Group ··· The Kucchan Group is mainly distributed in the west of Jozankei, while the Toyama Group is in the east, unconformably covering the Furubira Group, except around Kucchan and Kunitomi. The Kucchan Group is mainly composed of

andesitic pyroclastic rocks, and the Toyama Group clastic sediments. This two groups are considered to be of the same age, but their relationship is yet to be clarified because they are located in different areas.

1.3 Pliocene series

Nishino Formation : It is unconformable with the lower formations. The basal conglomerate is mainly covered with andesitic-dacitic pyroclastic rocks.

1.4 Quaternary system

The Quaternary includes Pleistocene andesite lavas and welded tuffs, and Holocene floodplain deposits.

2. Intrusive rocks

The Neogene Tertiary system is intruded by such igneous rocks as rhyolite, dacite, andesite, basalt, quartz porphyry and granitic rocks. It is possible to infer the period of intrusion from the age of the country rocks, and the lithologic character of the intrusive rocks (HASEGAWA and OSANAI, 1978). The age determination of the intrusive rocks and stage of intrusion are shown in Table 2 and Figure 3, respectively.

3. Tectonics

Igneous activities were frequent in this area in and after Miocene time. The lithofacies of the Miocene series show that those activities took place regularly in the specific area in each depositional stage of the formation. Therefore, tectonics will be considered mainly on the area in which volcanic activities occurred.

Except for the Jozankei Group, tectonics of the Furubira Group will be described. Since the presence of the Jozankei Group is intermittent, many points are yet to be clarified on the lithofacies and the tectonics, and the ore deposits are more closely connected to the Furubira Group than the Jozankei Group.

Table 2 K-Ar age of intrusive rocks in the Kunitomi-Jozankei-Chitose area.

Rock name	Locality	Country rock	K-Ar age	Refefences
andesite	Chitose	Yamato F.	10.3	MITI, 1979
quartz porphyry	Jozankei	Yamato F.	8.5	IGARASHI et al, 1977
	North of Jazankei	Yamato F.	9.5±0.7	NONOKUCHI, 1989
dacite			10.9±0.5	WATANABE et al, 1989
granitic rock	Toyaha	Jozankei G.	9.1±0.8	NONOKUCHI, 1989
			12.1±0.6	
			14.0±0.7	
			15.8±0.8	
			18.2±0.9	
granitic rock	Ohe	Kucchan F.	8.2±3.8	NITI, 1985
			6.6	HASEGAWA・OSANAI, 1978
granitic rock	South of Ohe	Shikaribetsu gawa F.	7.7	

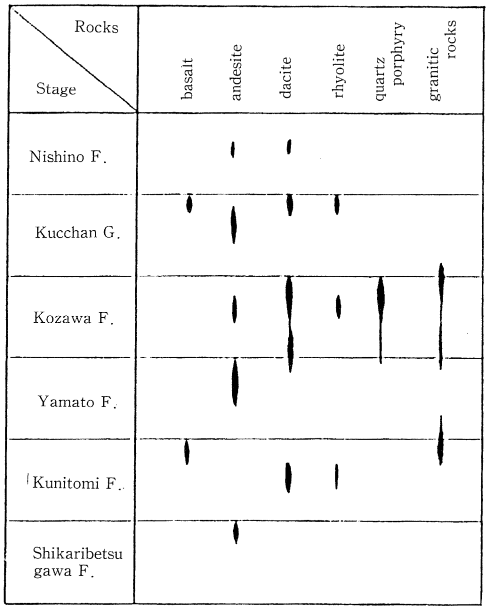


Fig. 3 Figure showing the intrusive stage of the igneous rocks.

3.1 Tectono-volcanic division

The Kunitomi-Jozankei-Chitose area is divided into three tectonic units, since different characteristics on lithofacies of the Miocene formations are seen among these units.

The Kunitomi-Jozankei area was once divided into four units ; i) the Kunitomi unit, ii) the Jozankei unit, iii) the Yoichi-Kucchan unit, and iv) the east end unit. Except for the east end unit, the units are further divided into subunits (HASEGAWA and OSANAI, 1978).

Since the completion of the geologic sheet map, "Sapporo" of scale 1/200,000 (ISHIDA et al., 1980), the geology of southeastern part of Jozankei has been clarified, and the division has been revised as to divide the east part of Jozankei. It is now called the Toyohiragawa subunit instead of the east end unit, and is included in the Jozankei unit where the Toyama Group is mainly disrtibuted. The Chitose area is included in the Jozankei unit under the temporary name of the Chitose subunit (Fig. 4).

The geological character of each unit be described in the following section.

1) Kunitomi unit … Volcanoes were active over this area in the Miocene with different appearances from place to place. The unit is divided into five subunits (K-1～K-5) by the lines running from northwest to southeast, since the parts of intense volcanic activities in each depositional stage tend to NW-SE direction. The character of each subunit is as follows :

K-1 subunit : The formations between the Shikaribetsugawa Fromation and the Kucchan Group are mainly composed of pyroclastic rocks and clastic sedements.

K-2 subunit : Dacite of the Kunitomi Formation is prominent.

K-3 subunit : The Jozankei Group and conglomerate of the Shikaribetsugawa Formation is distributed, with granitic rock intrusives.

K-4 subunit : Dacite and andesite of the Shikaribetsugawa Formation and dacite of the Kunitomi Formation in the southwestern and northeastern halves, respectively, but the boundary is unclear.

K-5 subunit: Andesite lavas and pyroclastic rocks of the Yamato Formation have extensive distribution.

2) Yoichi-Kucchan unit … The area contains clastic sediments. The ridgeline, along which pyroclastic rocks of the Yamato Formation is distributed, divides this unit into two subunits (M-1 and M-2).

M-1 subunit: This subunit is characterized by large amount of clastic sediments from the Shikaribetsugawa Formation to the Kucchan Group except for the Kozawa Formation, which is composed of rhyolite lavas and pyroclastic rocks.

M-2 subunit: The formations younger than the Yamato Formation are exposed, where clastic sediments are dominant, except for the Kozawa Formation, which is composed of rhyolite lavas and pyroclastic rocks.

3) Jozankei unit … The Jozankei unit is divided, by lines also running NW-SE, into J-1～J-6 subunits and the Toyohiragawa and the Chitose subunits which are in the south of the J-6 subunit. In the central part of the unit, i.e. in the J-2～J-5 subunits, the strata which are distributed at the northwestern part are younger as compared with one at the southeastern part. In its center, however, a fault runs NE-SW, causing upheaval of the southeastern part. The lithologic boundaries relatively clear in the southeast of the fault, while they are less clear in the northwest, making it difficult to delineate the lithologic boundaries. Therefore, the lithologic boundaries in the southeastern part were extended to the northwestern part and make the J-2' ～J-5' subunits.

J-1 subunit: The basement rock is located at or near the surface, with the Furubira Group covering it. Pyroclastic rocks are dominant in the formations from the Kunitomi Formation to the Kucchan Group.

J-2 subunit: Pyroclastic rocks of the Kunitomi Formation are composed of this subunit. The J-2' subunit make up by pyroclastic rocks of the Yamato Formation, and a drilling core indicates that pyroclastic rocks and lavas of the Kunitomi Formation and the Shikaribetsugawa Formation are laying under the Yamato Formation.

J-3 subunit: Conglomerate and andesite lavas of the Shikaribetsubawa Formation and pyroclastic rocks of the Kunitomi Formation cover the Jozankei Group. In the J-3' subunit, dacite lavas of the Kunitomi Formation are distributed.

J-4 subunit: Conglomerate and andesite lavas of the Shikaribetsugawa Formation and pyroclastic rocks of the Kunitomi Formation are distributed over the Jozankei Group. A depression took place in this area during the depositional stage of the Shikaribetsugawa Formation. The activity of andesitic volcanics occurred in the depression (HASEGAWA and OSANAI, 1978). The lavas of the Kunitomi Formation are located in the J-4' subunit, and the drilling cores indicate that andesite lavas of the Shikaribetsugawa Formation underlied the Kunitomi Formation.

J-5 subunit: The Jozankei Group is distributed in this subunit, and at its north end pyroclastic rocks of the Kozawa Formation overlies the group. The J-5' subunit consists of the Kozawa Formation, composed of pyroclastic rocks, and the Kucchan Group, composed of pyroclastic rocks and clastic sedments.

J-6 subunit: Lavas and pyroclastic rocks of the Yamato Formation are distributed in the entire area. The subunit contains much intrusive rocks.

Toyohiragawa subunit: The Toyama Group consists this subunit.

Chitose subunit: The eastern and western parts of this subunit have different characteristics. The western part contains lavas and pyroclastic rocks of the Yamato Formation, while the