ON THE FORM AND THE MINERALIZATIONS OF COPPER ORES IN THE ORO DENORO MINE, BRITISH COLUMBIA, CANADA

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The Oro Denoro Copper mine is one of the contact ore deposits scattered in Boundary District, British Columbia, Canada.

Many investigations such as geological surveys, geophysical prospectings, prospectings by drilling and underground prospectings were carried out at this mine and other mines around it from 1956 to 1968.

The geology of the Oro Denoro mine consists of sedimentary rock and various kinds of intrusive igneous rocks.

The sedimentary rock belongs to the Brooklyn Formation of the Palaeozoic era which consists principally of limestone and calcareous rock containing small amounts of tuff, pyroclastics, argillite and sharpstone. These sedimentary rocks have been widely given the folding and faulting. They were given the contact metasomatism by the intrusion of the granodiorite batholith of the Mesozoic era called Lion Creek Intrusive and Emma Intrusive.

The ore deposits are mainly grown around the skarn zone and granitic rocks.

The characteristics of the ore deposits are as follows:

(1) The metallic mineral in the copper ore consists largely of chalcopyrite containing a very small amounts of bornite and ores of gold and silver. The metallic gangue minerals are pyrite, magnetite, hematite, pyrrhotite and other iron ores.

(2) The zone rich in copper is divided into two types.

(a) The zone rich in copper is made up by various types of veins or banded ore bodies, the mineral deposition of which is controlled by many fissures in the skarn zone. As a result the continuity of the zone rich in copper is poor and the copper ore is produced as wedge or rib.

(b) The zone rich in copper shows bedded ore bodies, the mineral deposition of which is controlled by fissures in layered limestone, fracture zones or permeable skarn. As a result the copper content in the ore bodies is low, although they are big.

(3) In general the mineralization is active in zones where the skarnization has been advanced. The skarn accompanied by chalcopyrite is discontinuous, of irregular shape and distributed mainly in the central zone of the zone of high grade skarn. The grade of the skarnization is decreased concentrically on the horizontal cross section from its center to the outside.

(4) The kinds of the skarn minerals are nearly the same every place, which consist largely of garnet such as andradite and grossularite rich in calcium found in contact metasomatic deposits in Japan.

INTRODUCTION

The Oro Denoro mine is one of the contact metasomatic deposits scattered in Boundary District, B.C., Canada, which seems to have been formed by the intrusion

of granodiorite or quartz-diorite in the Mesozoic era into calcareous rocks consisting principally of the limestone of the Palaeozoic era. In 1967 in order to make them clear, Furukawa Co., Ltd. carried out many

prospectings by drilling in the area assumed to be the central zone of the mineralization.

The results of those drillings revealed unexpectedly that the shape of the ore deposits was complicated and that the ore shoots were banded ore bodies or lenticular veins. The amount of ore was estimated by various methods. The trend surface analysis using an electronic computer was one of them, of which the result was already reported by Yonebayashi and Kamura (1969).

The characteristics of the Oro Denoro mine and ore deposits around it viewed from the points of geology and the science of mineral deposit, and several problems in prospecting contact metasomatic deposits will be discussed in this report.

LOCATION AND PHYSIOGRAPHY

The location of the Oro Denoro mine belongs to the Greenwood Mining Division, Summit Camp., B.C., according to the classification by the Department of Mine and Petroleum Resources of Canada. The mine is located about 317 miles southeast of Vancouver, 14 miles east of Greenwood and near the south side of the No. 3 Trans-provincial Highway* (Fig. 1).

The area around the mine is gently undulating plain of 3,000 to 5,000 feet above the sea level. The main rivers are the Kettle River and Granby River. Their tributary waters are the Fisherman, Lion, Boundary Creek and others. All those rivers flow into the Columbia River (Fig. 2).

Fig. 1 Location map

* Latitude 49°07'N, Longitude 118°35'W

Fig. 2 Geological map of Phoenix - Oro Denoro properties. (From Brock *et al.*, 1902; the present author partly modified) Tertiary (1: Trachyte flow, 2: Pulaskite dykes, sills and plugs, 3: Diorite shills), Mesozoic (4: Lion creek int., Emma int.), 5: Paleozoic (Brooklyne f., 6: Volcanics, 7: Limestone, 8: Limestone breccia, 9: Skarn,) 10: Mineral deposits, 11: Bedding, 12: Fault, 13 Sheared zone, 14: Geological contact. (Scale unit is feet).

GEOLOGY

The strata developed around the Oro Denoro mine are classified by Brock (1902), Carswell (1957), and Weymark (1966) as shown in Table 1 and Fig. 2.

1. Palaeozoic

The strata of the Palaeozoic era are divided into two groups of the Knob Hill and the Attwood, which are of unconformity each other.

The Knob Hill Group consists principally of rock apparently altered from igneous rock in which cherts are locally mixed containing small particles of sandstone,

shale, porphyrite, tuff, argillite and limestone. The rock is siliceous as a whole.

The Attwood Group is further divided into two, of which the upper part is called Rawhide Formation and the lower part is called Brooklyn Formation.

The Brooklyn Formation consisting principally of limestone and calcareous sandstone with small amounts of tuff, tuffite and sharpstone mixed in it is economically the most important, which stratum contains nearly all the main ore deposits in this area. The limestone and tuff received silicification and give rise locally jasperoid.

The limestone and calcareous rock received contact metasomatism over a wide

Table 1 Generalized stratigraphic section of the Oro Denoro district and main rock types.

Quaternary	Glacial and Recent	Modified drift, Clay Sand, Gravel
Tertiary	Miocene?	Midway Igneous Group pulsaskite porphyry (alkali syenite, porphyry) diorite (augite porphyrite) in stocks, dykes and sills
	Oligocene?	Midway volcanic Group lavas, basalt, andesite, trachyte
		Kettle River Formation conglomerate, sandstone, shale, arkose
Mesozoic	Cretaceous ~ Jurassic	Lion Greek and Emma Intrusives granodiorite batholith augite syenite, porphyry in dykes
Paleozoic	Carboniferous (?)	Attwood Group Rawhide Formation argillites shale, intercalated lenses of sandstone, conglomerate with chert and jasper pebbles Brooklyn Formation crystalline limestone and calcareous shale with some argillites and tuffs in part by lime silicates or sharpstone, conglomerate beds. Skarn are zones - contact
		Knob Hill Group porphyrites, breccias, tuffs, silicified ash rocks, cherts with small lenses of argillites andesites and limestones. The group includes a few later dykes and sills of hornblende and augite porphyrite

(From Brock, R.W. *et al.*, 1902, the author partly modified.)

range by the intrusion of granodiorite of the latter period, and the original rock became partly skarn minerals of such limesilicates as epidote and garnet, thus skarn zone appearing.

The mineralization in the Oro Denoro mine also took place in the skarn zone.

The Rawhide Formation consisting of argillite and shale covers the Brooklyn Formation conformingly.

2. Mesozoic (Lion Creek and Emma Intrusives)

The batholith of granodiorite is widely distributed northwest of the Phoenix mine

Fig. 3 Surface geological map of the Oro Denoro mine.

1: Midway ign. gr. (Basic dykes, pulaskite), 2: Midway ign. gr. (Diorite sill), 3: Kettle Riv F., 4: Lion Creek & Emma int., Brooklyn F. (5: Limestone, 6: Alt. of 1st. ch. and ss., 7: Pyroclastics), 8: Skarn, 9: Surface trenches, 10: Diamond drill holes, 11: Ore chutes, 12: Winzes, 13: Shafts, 14: Fault, 15: Dip & strike.

Fig. 4 Geological section of the Oro Denoro copper mine.

1: Copper enriched zone, 2: Granodiorite, 3: Diorite sill, 4: Limestone, 5: Limestone rich skarn, 6: Skarn, 7: Diamond drilling hole.

and the Oro Denoro mine. The period of its formation has been assumed to be Jurassic to Cretaceous from the comparison with the similar intrusives distributed in

the South Central Province (Carswell, 1957).

The batholith in the Oro Denoro area is divided into two types lithologically. They are both granodiorites and it is difficult to differentiate their lithofacies with the unaided eyes. From the view point of mineral composition, the Emma Intrusive contains a little less quartz and ferro-magnesium mineral than that of the Lion Creek Intrusive.

Weak chilled margin is found in these intrusive rocks near boundaries between them and old rocks. Angular tuff and the xenolith of altered limestone are observed in the intrusive rocks. The rocks are in general of light color and their texture is in general porphyritic under a microscope. Phenocryst consists of strongly altered plagioclase. The groundmass consists of quartz, plagioclase, biotite, hornblende, and chlorite accompanying small amount of magnetite. Feldspar is in most cases altered to sericite, kaolinite and other phyllosilicate. Mafic mineral is partly altered to chlorite.

The batholith makes up stock and small irregular rocks in general near the north boundary of the Oro Denoro mine. The rock of the form of dyke and offshoot are observed in ore deposits, which suggests that the mineralization took place in igneous rocks, too (Figs. 3 and 4).

3. Tertiary

The Tertiary is classified into three groups, namely, from the bottom, the Kettle River Formation consisting of sedimentary rocks, the Midway Volcanic Group consisting of volcanic rocks and the Midway Igneous Group consisting of intermediate and acid rocks.

The Kettle River Formation consists principally of arkose sandstone, conglomerate and shale. The Midway Volcanic Group distributed widely in Boundary

District was produced by the igneous activity of Oligocene~Miocene. It is a lava flow of the mineral composition of the range from basalt to trachyte and covers the lower Kettle River Formation nearly conformably with various thickness. The Midway Igneous Group produced by the last igneous activity is the pulaskite porphyry (alkali syenite porphyry) called diorite and has in most cases the form of dyke and sill which intruded into the older bed. Among those the diorite is especially related with the Oro Denoro ore deposit, which intrudes into the central part of the deposit in the form of sill, apparently separating the deposit into two. The depth of the intrusion is nearly horizontal or slightly inclined in NW direction at 3,300 feet above the sea level. Its form was confirmed by several deep drillings.

The diorite was observed to have the following characteristics under a microscope that phenocryst altered a little shows aphanitic texture with greenish gray matrix and that it consists of chlorite, biotite, augite, hornblende and small amounts of quartz and feldspar. The feldspar is a little metamorphosed.

The pulaskite observed on the ground surface, underground and drilling cores near the Oro Denoro mine shows in most cases the form of dyke. The intrusion of the sill of diorite is not observed and the pulaskite is assumed to be the newest intrusive rock.

The dyke of basalt and andesite is observed in the southern rim of the Oro Denoro area, of which relationship with other rocks from the view point of time is not known. Most of those rocks show porphyrite of small size of crystals, some of which are disseminated by pyrite.

4. Geological structure

The geological structure of this area is

not known in detail, because the outcrop of rocks is poor and no structure of the original rock remains in the skarn zone.

The strike and inclination of the limestone and calcareous sandstone in the Brooklyn Formation are evidently observed on the ground surface near Phoenix mine and the south side of Oro Denoro mine, which suggests the original structure of this area. According to this, the strike is generally NE to NW and the inclination is very steep or nearly vertical. As a whole the structure is homoclinal or isoclinal folding with vertical axis. There is no fault in the mineralized zone in the Oro Denoro mine so big that might affect the geological structure.

There are many fissures, faults with small displacements and fracture zones in the Oro Denoro mineralized zone. Their strikes and inclinations are different from each other and their structural relationships are not known.

ORE DEPOSITS

Most of commercially valuable ore deposits in Boundary District have grown in limestone near the boundary between granite and limestone (Figs. 2 and 3). Most of the ore deposits of the Oro Denoro, Emma, Jumbo and others have grown in the skarn zone which was formed from limestone or calcareous rocks given the contact metamorphism by the intrusion of Lion Creek or Emma granodiorite in the Brooklyn Formation.

1. Ore deposits of the Oro Denoro

The exposure of skarn is observed along the contact part between the Lion Creek granodiorite and Brooklyn Formation in the area expanding about 1200 feet north to south and about 800 feet east to west (Fig. 3).

North of gride 4200S near granodiorite

batholith, the similar granodiorite is found in the form of stock or dyke and it apparently forms a complex zone mixed complicatedly with skarn zone.

The mineralized zone has been confirmed up to the level as high as 2900 feet above the sea level, the thickness of which is about 800 feet from the surface (the out-crop).

The Oro Denoro ore deposit is that of copper like the surrounding ore deposits and its principal ore mineral is chalcopyrite accompanied by small amount of bornite and very little amount of mineral of gold and silver.

Pyrite, magnetite, hematite and pyrrhotite have been found as metallic gangue minerals, among which the hematite is apparently the secondary mineral. Garnet, epidote, quartz-silica, calcite-carbonate, amphibole, pyroxene, chlorite and feldspathoids have been found as nonmetallic minerals.

As the results of many diamond-drillings the approximate shape of the ore shoot in the Oro Denoro copper ore deposits has been found. Detailed investigations have revealed that the ore shoot is irregular and lacks continuity.

From the above-described facts the ore shoot is apparently not massive but the collection of beds or veins of minerals.

Fig. 4 shows the cross section near the center of the ore shoot. Figs. 4-A and 4-B show the cross section from west to east. Figs. 4-C and 4-D show the cross section from south to north. From these cross sections the ore shoot is divided into five ore beds, of which the ore beds (II) and (IV) are most dominant. The part between an ore bed and the next one is scarcely mineralized or disseminated by very little amount of chalcopyrite.

Fig. 5 is a zoning map that shows the correlation among the contact metamorphism, mineralization, and mineral paragenesis constructed from the results of the areal and drilling prospectings.

This figure shows that the zone mineralized remarkably nearly coincides with the zone contact-altered heavily and that the mineralization of copper is most conspicuous near the intersection of grides 4400S and 5600W. Horizontally viewing, the degree of the contact metamorphism decreases concentrically from the center toward outside.

As shown in Fig. 6, the parageneses of copper sulphide mineral and other minerals in the ore body are divided into three types:

- (1) copper sulphide containing hematite and magnetite,
- (2) copper sulphide containing much amount of magnetite,
- (3) copper sulphide containing calcite or crystalized limestone.

The first type exists in the central part of the mineralized zone, which was revealed by the drilling cores of F-12, WC-29A, F-37 and others.

The second type exists in the complex zone of the mixture of granodiorite and skarn, which were revealed by the drilling cores of WC-27A, F-38, F-14B and others. This type of combination of minerals consists mostly of magnetite containing chalcopyrite only. The similar type is found in northern old mining tunnels in the Oro Denoro mine. What is assumed to its extension is found in the ore deposits of Emma and Swallow.

The third type is observed in the whole area of mineralization as revealed by the drilling cores of F-20, F-17, F-15 and others, where copper minerals exist as calcite and dissemination in voids in limestone.

Fig. 5 Assumed zoning map of the Oro Denoro copper mine.

1: Copper enriched zone with hematite and magnetite, 2: Copper enriched zone with magnetite, 3: Sectional copper enriched zone, 4: Zone of low grade skarn, 5: Mixed zone of granodiorite and skarn, 6: Granodiorite mass, 7: Zone intercalated by limestone seam between skarn and diorite sill, 8: Massive limestone, 9: Old pit, 10: Diamond drill holes.

Fig. 6 Diamond drill hole records of the Oro Denoro copper mine.

1: Skarn, 2: Tuff & tuffaceous rock, 3: Ss., Shale & slate, 4: Calcite & limestone stringer, 5: Granodiorite, 6: Diorite, 7: Chalcopryrite veinlets and impregnation very rich zone, 8: do. rich zone, 9: Chalcopryrite impregnation, 10: Magnetite, 11: Hematite.

It is very difficult to understand only from the results of drilling prospectings the conditions in which the ore shoot was formed. This is especially the case for such places as this mine where the original geological structure is not clear owing to contact alteration.

The author carried out the trend surface analysis of the ore shoot basing on the geological investigations and making use of a computer. Although several problems are left in the analysis due to the complexity of the fissure system, the location of the ore shoot given by this is fairly in good agreement with the zoning map mentioned above (Yonebayashi *et al.*, 1969).

It is assumed that the trend of the ore shoots of this mine takes the direction from south to north as a whole and that they are arranged like an echelon. This assumption is based on the following two facts.

Firstly, the skarn zone is extended along the running direction of limestone in the Brooklyn Formation and its cleavages run generally from north to south which are probably controlled by the slightly folded structure of the limestone before the contact metamorphism.

Secondly, all the anomalies in the self-potential survey and geomagnetic survey are extended toward north or south, which is in good agreement with the direction of the extension of the ore shoots.

The part between one ore shoot and the next one is scarcely altered, which is probably because the mineralization took place along joints, fissures or fractures formed in the process of the contact metamorphism.

2. Ore deposits of the other mines

Phoenix mine: The geology of this mine, as shown in Figs. 2 and 7, consists of sharpstone, argillite, skarn (chlorite, epidote and garnet), layered limestone, and massive limestone, and it belongs to the Brooklyn Formation or Rawhide Formation. The strike of the stratum is in the direction of NE to NW and inclined 40° to 60° N, thus a monoclinical structure being formed.

The mineralization is found in the particular stratum of chlorite-epidote skarn formed from layered limestone. The ore shoot of copper exists in the zone where limestone was given the contact metamorphism, fissures, crushing and slight folding or in other permeable places. Thus, the

Fig. 7 Geological section of the Phoenix copper mine.

1: Sharpstone, 2: Argillite, 3: Quartzite, 4: Skarn, 5: Ore bed, 6: Kettle River arkose, 7: Pulaskite, 8: Pulaskite dyke, 9: Andesite dyke.

deposition and concentration of copper minerals took place along the bedding of limestone to form an ore deposit of tremendous scale.

The size of the ore body is confirmed at present to be about 200 feet in the horizontal direction, about 800 feet in the inclined direction and about 200 feet in thickness.

Mother Load mine: This mine also shows the similar shape and structure as Phoenix mine.

North of the Oro Denoro, there exist several small ore deposits such as Emma, Jumbo, Blue Bell, and Swallow, most of which are located east of the Emma intrusive igneous rock body and extended in the direction of north or north east.

The ore deposits in this area consist mainly of chalcopyrite and contains much magnetite and very little ores of gold and silver as those in the Oro Denoro. The mineralized zone is developed, being controlled by such geologically weak lines as fracture or crushed zone.

3. Sequence of contact metasomatism and mineralization

The contact alteration in this area was caused by the heat and emanation produced in the process of the solidification of the Lion Creek or Emma intrusive rock.

It is assumed that the volume of the intrusive rock changed during its cooling and solidification in the first stage causing small faults, slips, fractures or fissures in the surrounding rocks and that several brecciated zones were produced by their congregation.

In the next stage, iron and other elements moved from igneous rocks and host rocks to replace limestone, which gave rise to a great amount of the deposition of magnetite and the formation of skarn minerals.

Then, sulphide mineral of the combination of either chalcopyrite-gold-silver or pyrrhotite-gold-silver was crystalized and deposited in the above mentioned skarn zone or host rock near the skarn zone.

On the other hand, fissures and cleavages in brecciated zone were filled with the above mentioned sulphide mineral, calcite, quartz and others. The sulphide mineral and the thin veins of calcite and quartz cut each other, which suggests that both minerals were crystalized all through the period during which contact alteration and mineralization were taking place.

DISCUSSIONS

1. On the metasomatism and mineralization

As described above, the characteristics of the mineralization of each contact metasomatic deposit in Oro Denoro area are somewhat different from those of the others, depending on its distance to the related igneous rock, the geological structure and the characteristics of the host rock. On the other hand, the following three points are commonly observed:

(1) Generally speaking, the skarn minerals in this area consist of andradite and grossuralite rich in calcium and small amounts of epidote and diopside. This kind of combination of minerals is found in contact metasomatic deposits in Japan, too. However, the skarn minerals in Whitehorse Copper Belt developed along the Pacific coast of B.C. District consist of garnets which contain more magnesium than those in Oro Denoro area (Morinaga *et al.*, 1968).

(2) Copper sulphide coexists with much amount of magnetite. The more magnetite is found, the closer we approach

the igneous rock related with the formation of the ore deposit.

(3) The ore mineral is mostly chalcopyrite. A very little amount of bornite assumed to be the secondary mineral is found, but galena and sphalerite are scarcely found. Ore deposits of this kind of characteristics are found in other places in the world, too. This type of ore deposit has been formed when the related igneous rock is acidic or intermediate and host rock is combined with limestone or calcareous rocks.

The ore deposit has been formed in places relatively near to the related igneous rock. It is common that such small body of rock separated from the main body of batholith as stock or lacolith is directly related with the formation of the ore deposit. In some cases, complex zones are formed by the complicated mixture of the skarn and igneous rock.

Miyazawa (1966) has classified contact metasomatic deposits in Japan into three types; Kamaishi-type (Kamaishi, Yaguki, and Akakura mines), Kamioka-Nakadatsu-type (Kamioka and Nakadatsu mines) and Chichibu-type (Chichibu mine). The ore deposit in Oro Denoro area can be classified into the Kamaishi-type from the view point of its structural characteristics and mineral paragenesis.

2. On the structural control of the ore deposits

Ore deposits in this area are classified into four types according to their forms;

- (1) Bedded type: (Phoenix mine)
- (2) Banded type: (Oro Denoro, Emma, Jumbo mines etc.)
- (3) Disseminated type: (ore deposits in the complex zone)
- (4) Vein type: (surroundings around the complex zone)

These types of ore deposits can be explained in more detail as following:

(1) Bedded type: When the related igneous rock is separated from the host rock, ore solution has been deposited and crystallized in the brecciated zone formed by the congregation of fissures, small faults or slight foldings or in some particular stratum with strong intraformational folding. The Mozumi deposit of Kamioka mine in Japan, and Huanzala ore deposit in Peru (Oikawa, 1968) belong to this type.

(2) Banded type: Several ore bodies are arranged parallelly to each other in the central part of the Oro Denoro mine. Mineralization is scarcely observed in the space between an ore body and the adjacent one. Ore solution has been deposited and crystallized preferentially at particular crushed zones in the host rock. Examples of this type are also found in the ore deposit in Whitehorse Copper Belt and that in Kamaishi mine.

(3) Disseminated type: Mineral solution has been deposited and crystallized in voids or fissures between the host rock and igneous rock to disseminate them in the complex zone where skarn and igneous rock are mixed each other. Although the ore body is massive, the copper grade in it is much lower than that in the ore of other type.

(4) Vein type: Ore deposits of vein type are also found in the surroundings around the complex zone. This type of vein is also found around the ore bodies in Kamioka and Chichibu mines. This was produced by the deposition and crystallization of ore solution in fissures near the ore body that had been separated from the center of the ore body and had penetrated through the ore and rock. Its grade is too low to be mined commercially.

As described above, there exist several types of contact metasomatic deposits, which can be explained as the following.

As ore solution is separated farther from the related igneous rock, the temperature, pressure and the permeating ability decrease and the structural control affecting the mineralization becomes more conspicuous. Even when the ore solution loses its capability to replace the host rock, the vein type or bedded type of ore deposit is formed filling such places with many cracks as fault zone, fracture zone or folding axis in the host rock, or the voids near the boundary between a stratum and its cap rock.

3. On the relation of contact metasomatism and sulphide mineralization

It can be assumed that the host rock and the fractures in the igneous rock were formed in two stages (Table 2).

Table 2 A generalized sequence of skarn metasomatism and mineralization.

Calcite and quartz veins
~~~~~ Fracturing ~~~~~
Deposition of Sulphide minerals Chalcopyrite Bornite + Au, Ag Pyrrhotite + Au, Ag Pyrite
Calcite and quartz
~~~~~ Fracturing ~~~~~
Deposition of magnetite as replacement or filling in breccia zones with skarn minerals (garnet, epidote and actinorite)
~~ Brecciation, faulting, fracturing ~~
Contact metasomatism by the Lion Creek and the Emma Intrusives.

In the first stage, fissures, small faults and brecciated zone were formed by the pressure owing to the intrusion of igneous

rock into the host rock. It is assumed that the direction of these trends coincide fairly well with that of the intrusion of the igneous rock, and that their formation was principally caused by compression making various elements move easily in the contact metamorphism.

In the second stage, fissures, fractures, brecciated zone and small faults were formed again by the tension owing to the contraction at the cooling and solidification of igneous rock. Their voids acted as the paths of ore solution at mineralization.

These two stages are the phenomena related with the intrusion of the identical igneous rock. Therefore the time difference between them is probably not so big.

On the other hand, the crystallization of calcite and that of quartz occurred continuously through the two stages as mentioned above.

4. The problems on the geological prospecting of the contact ore deposits

Various geological studies and prospectings had been carried out at the Oro Denoro mine. Nevertheless they had not clarified the characteristics of the mine such as its continuity and the form of the ore shoots. This was because most geologists carried out their prospectings basing on the assumption that the mineralization had occurred in the whole part of the skarn zone. They drilled quite at random and calculated the ore reserve assuming the whole skarn zone to be the ore body.

Present investigations showed that the mineralization had occurred only at some selected parts of the skarn zone. The geological studies and prospectings of the contact metasomatic deposit should be carried out hereafter taking into consideration the followings;

- (1) There exists some geological time

gap between the contact metamorphism and the mineralization.

(2) The permeating pressure and temperature of ore solution decrease, as the distance between the host rock and the related igneous rock increases. Therefore, the structural control given to the mineralization increases with the distance, and voids owing to faults, folding axis, fractures, brecciated zones and fissures act as places for the formation of ore deposition.

(3) The form and structure of the ore deposit, such as massive, bedded, banded, disseminated, or vein, are determined by such geological conditions as the temperature and pressure of ore solution, the distance between the host rock and igneous rock, and the existence of voids to act as the path for the ore solution.

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カナダ British Columbia 州オロ・デノロ銅鉱山の形態と鉱化作用について

嘉 村 豊

オロ・デノロ銅鉱山およびその周辺の接触交代鉱床の探査の結果、富鉱部の形態は複雑で連続性に乏しく脈状・層状・鉱層状あるいは鉱染状の鉱体であることが判明した。従来スカルン化作用の場と鉱化作用の場とが一致していると考えられがちであったが、富鉱部を形成するためには他の地質的な種々の条件が必要である。すなわちスカルン化作用と鉱化作用との間には時間的に若干の差があること、関係火成岩と母岩との距離によって構造規制の受け方が異なること、鉱液の温度・圧力の度合などによって富鉱部は種々の形態をとることが認められた。