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Grong Gruber AS		F.M. Vokes		

Tittel

Summary of microscopical investigations on drill core specimens from Bh 4, Rørvatn, Gjersvik District

Forfatter	Dato	År	Bedrift (Oppdragsgiver og/eller oppdragstaker)
Haitian, Sun	jun	1991	Norsulfid Grong Gruber AS

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Fagområde	Dokument type	Forekomster (forekomst, gruvefelt, undersøkelsesfelt)
Boring Mineralogi		Rørvatn
Råstoffgruppe	**Råstofftype**	
Malm/metall	Cu,Zn	

Sammendrag, innholdsfortegnelse eller innholdsbeskrivelse

Beskriver mikroskoperte prøver fra de forskjellige nivå i bh 4. Det antas at disse undersøkelsene kan danne grunnlaget for undersøkelse av alle borprøver senere .
Bergartstyper beskrives, likeså hydrotermal endring og mineraliseringer. Hovedelen av bergarter i hullet består av metamafiske bergarter med mindre innslag av sure typer.
Måten mineraliseringer opptrer på, er tolket til "feeder-zone" type som gir mulighet til å påvise en massiv sulfidforekomst.

Summary of Identifying Specimen With Microscope For A Drill Core, at RORVATH, Grong District

1 Introduction

This report is a systematic summary identifying specimen with microscope for a drilling core 4#, at RORVATH, Grong district, which was finished in 1984. It covers 184.25 m, from 290 to 374.25 m, in depth.

The represent 50 bore specimen from different levels of the drilling core in depth have been supplied by GRONG GRUBER A/B, and twenty-nine of them were selected to make 21 thin sections and 9 polished thin sections (Section No. 51558 includes both of a thin section and a polished thin section), respectively, on the basis of the material of drilling record and the megascopic observation of bore specimen. Each of them has been identified under microscope (seeing enclosure) and it is believed that these can represent the fundamental feature of all bore specimen.

2 Conclusion

2.1 Metamorphic Characteristics

The megascope features of bore specimen illustrate that they are all massive, homogeneous or non-homogeneous, dark-moderate or pale-grey greenish in color, cryptocrystalline and microcrystalline with strong schistosity.

The mineral assemblages of bore specimen identified under microscope are predominantly chlorite + epidote + biotite + muscovite + albite + quartz + carbonate + sulphides, occasionally with a very small amount of grossularite (e.g., Section No.21560), of which chlorite and albite are the most dominant components although each mineral varies greatly in different specimen in content. Chlorite is mainly mica-like or irregular scale, while albite occurs either as tabular porphyritic crystal or as matrix. All chlorite and porphyritic albite are obviously oriented in the direction along schistosity.

Thus, these bore specimen represent a kind of rock with metamorphic grade up to greenstone schist facies. They are all named as greenstone schist.

2.2 Rock Lithology

2.2.1 General Characteristics

On the basis of main mineral assemblages and their relative contents in rock, these specimen can be divided into two groups: One is the metamafic rock, consisting mainly of mafic minerals, chlorite and epidote, ranging from 70 to 90 per cent in content; the other is the metafelsic rock, composed predominantly of felsic minerals, albite and quartz, ranging from 60 to 80 per cent. Some typical textures indicating the nature of primary rocks of specimen, such as metaporphyritic, metaamygdaloidal, metagabbro and meta rock-debris etc, occur widespreadly in both two types of metamorphic rocks and can be easily recognized under microscope.

The main mineral assemblages and the special textures of the rock indicate that these metamorphic rocks are a kind of metavolcanites, probably belonging to the spilite-keratophyre series.

Owing to the fact that there have been short of material both of rock-chemical analysis and of occurrence and structure of the metamorphic rock in field, the name of rocks are only preliminarily given on the basis of mineral assemblages and textures.

2.2.2 Metamafic Rocks

Metamorphic rock is a bigger group of rocks in comparison with metafelsic rock because it covers most portion of the drilling core. Twenty-three of all identified bore specimen might have been considered to belong to this group.

A Main mineral Assemblage and Their Characteristics

Metamafic rocks comprise predominantly chlorite and albite with minor amounts of epidote and muscovite, and, at places, of quartz and carbonate which occur as hydrothermal altered minerals.

Chlorite is usually over 60 per cent in content, sometimes, concentrates over 90 per cent to constitute the bands of chlorite in the rock. Epidote is non-homogeneous in occurrence, either less 10 per cent or disappearance in content, and occurs mainly as two styles: one is allotriomorphic, fine-grained individual or aggregate of crystals, about 0.05 - 0.2 mm in size; the other is amygdales (seeing description in follow). Albite occurs largely as porphyritic crystal of albits setting in matrix, consisting predominantly of chlorite and felsic minerals which are too fine, generally less 0.05 mm in size, to be distinguished each other under microscope. The porphyritic crystal of albites is usually less 40 per cent of all felsic mineral in content. Albite is euhedral, tabular crystals with obvious albite-like twins, ranging from 0.1 to 1 mm in size, and occurs mainly as individual, occasionally as aggregate of crystals, which constitutes glomeropor phyritic crystal (e.g. Section, No. 21546).

B Typicla Textures

Some typical textures indicating the nature of primary rock have still been remained in the metamafic rock, which they are often recognized to occur extensively in mafic volcanites.

Metaporphyritic texture: This one, comprising mainly porphyritic crystal of albites (usually less 15 % in content) setting in matrix, is very common to occur in most of specimen of the metamafic rock. Almost all porphyritic crystal of albites are oriented in the direction along schistority and surrounded by the schistority.

Meta-amygdaloidal texture: This kind of texture is limited to occur in certain portion of the drilling core because it has only been recognized to occur extensively within 11 thin sections (that is, Section No. 21536, 21540, 21541, 21544, 21545, 21546, 21547, 21548, 21558, 21560, 21561). It is very interesting that the porphyritic texture becomes more obvious in the rocks where the meta-amygdaloidal texture appears. The shape of amygdales is predominantly circular with generally 0.1 - 1 mm, occasionally 3 mm in diameter, lessly ellipse which the extending direction of long axis is coincident with the one of schistority. The component of amygdales is mainly composed of crystalline individual or aggregate of epidote, occasionally of mineral assemblages of epidote + quartz or epidote + chlorite + quartz (e.g. Section No 21560). These amygdales are all surrounded by the schistority. The extensive occurrence of amygdates in rock seems to indicate that the primary rock of the metamafic rock with meta-amygdaloidal texture may be a kind of lava.

Metagabbroic texture: This one, consisting mainly of crystalline epidote filling within the frames composed of tabular albites, is not common in rocks. It is only recognized in Section No.21559.

C Types of Primary Rock

The metamafic rock can be subdivided into two types on the basis of the typical textures which occur within rock. They may represent two different kinds of primary rock.

One is characterized by the obvious metaporphyritic and meta-amygdaloidal textures. This kind of metamafic rock is probably a metamafic lava.

The other is that with the occurrence of neither meta-amygdaloidal nor metaporphyritic or very less metaporphyritic textures in rock. However, this kind of the metamafic rock contains some amounts of muscovite associated with chlorite. Meanwhile, It is noticed that muscovite seldom occurs within the first type just mentioned. Thus, this kind of the metamafic rock may belongs to a metamafic tuff. Six specimen, that is, Section No. 21549, 21550, 21551, 21552, 21553 and 21554, might have been considered as a representation of this type. These specimen occur mainly in the portion of drilling core ranging from 313 to 334 m in depth.

2.2.3 Metafelsic Rock

Seven of all bore specimen have been identified to belong to metafelsic rock. They occur respectively in four portions of the drilling core, that is, from 294.46 to 295.60 m (Section No. 21538, 21539), 301.09 m (Section No. 21542), from 347.73 to 350.22 m (Section No. 21557, 21558) and from 368.55 to 370.86 m (Section No. 21562, 21563) in depth.

A Main Mineral Assemblage and Their Characteristics

metafelsic rock consists predominantly of albite, quartz and chlorite with minor amounts of biotite, sericite and carbonate. Felsic minerals, ranging from 60 to 80 per cent in content, can be subdivided into two types: porphyritic crystal of albites and matrix. The porphyritic crystal of albites is mainly euhedral, tabular with obvious twins, ranging either from 0.1 to 0.3 mm (e.g., Sections No. 21538, 21539, 21542) or from 0.2 to 0.6 mm (seeing Sections No. 21558, 21562, 21563) in size. The felsic minerals of matrix are allotriomorphic fine-grained, generally less 0.05 mm in size, which they are probably albite or quartz. Speaking exactly, however, they are too fine to be distinguished each other under microscope. Biotites are allotriomorphic or euhedral, about 0.1 - 0.5 mm in size, and some of them are wholly or partly replaced by chlorite. Biotite occurs only in certain specimen, for example, Sections No. 21538, 21539 and 21542, while is seldom recognized in the others. Chlorite is mica-like, but oriented along the direction of schistority. Sericite, carbonate and some of quartzs probably belong to the altered minerals.

B Some typical Textures

Metaporpyritic texture: Almost all metafelsic rocks are characterized by metaporphyritic texture which comprises largely albites and lessly biotites setting in matrix. The metaporphyritic crystal is usually less 30 per cent in content. Almost all metaporphyritic crystals of the albite are oriented along the direction of schistority, and some of them are obviously surrounded by schistority (e.g. Sections No. 21562, 21563).

Meta rock-debris texture: This kind of texture, composed mainly of aggregate of quartz + albite + biotite, is not common in rocks, it is only recognized to occur in Section No. 21542.

C Types of Primary Rocks

Two possibilities regarding the type of primary rocks of theses metafelsic rocks have been considered: One is that they were formed by hydrothermal alteration, for instance, some specimen have been named as altered rock because they are almostly composed of altered minerals, quartz and carbonate, (e.g. Section No. 21557). In addition, some specimen, such as Section No. 21558. illustrate the relationship of replacement between matemafic and metafelsic rocks in megascopic characteristics, which is similar with that of feed zone in volcanogenic massive sulphide deposits; The other is that they are probably metafelsic volcanic lava or metasubvolcate because the porphyritic crystal of albites in these rocks were obviously replaced by the altered minerals, such as sericite and carbonate, and some special textures have been recognized to exist in these rocks, e.g. meta rock-debris texture.

2.3 Hydrothermal Alteration

Hydrothermal alterations are extensive but non-homogeneous, and are linear-type but not planed-type in rock specimen of the drilling core. Generally speaking, They are obviously controlled by fissures in accurrence. Thus, Some specimen of them are strongly associated with alteration, for instence, Section No. 21541, 21548 etc, even more, some became the altered rocks, e.g. Section No. 21557. But others seldom, such as Section No. 21539, 21549, 21551, 21558, 21563, 24564 etc.

Hydrothermal alterations are predominantly silicification and carbonitization, which occur widespreadly, lessly albitization, chloritization and muscovitization, which are located to exist in certain places of the drilling core.

Hydrothermal alterations can be subdivided into two types on the basis of the mode of occurrence: The first is hydrothermal altered veins, consisting mainly of quartz and carbonate, which are usually several millimeters in width. The contact between altered vein and country rock is sharp. They were formed mainly by hydrothermal filling processes; The second, as dominating type of hydrothermal alterations, is mainly metasomatic disseminated alterations, comprising predominantly silicification and carbonatization with minor amounts of albitization and chloritization. They are non-homogenous in occurrence, ranging from several millimeters to several or tens centimeters wide when appeared in the drilling core. The altered minerals vary from 40 up to 90 per cent in content in relation to the intensity of hydrothermal alterations. The mineralization are mainly related with the second type of hydrothermal alterations.

2.4 Mineralization

The mineralization discovered in the drilling core are mainly linear-type, and limited to occur in certain portions, in where the strongest mineralization are in 317 - 325 m (e.g. Sections No. 21550, 21551, 21552) and 359 - 360.5 m (seeing Section No. 21560, 21561), which the metallic minerals can be concentrated up to 30 per cent in the largest content, and in where the weak mineralization have been found to occur in several places, such as about 304 m (seeing Section No. 21545), about 334 m (Section No. 21554), about 340 m (Section No.21556) and about 350 m (Section No. 21558) in depth, which the metallic minerals are usually less 10 per cent in content. All mineralizations are associated with extensive hydrothermal alterations.

The mineralization can be divided into two types: fine vein, distributing along the fissures, and disseminated. Generally speaking, the vein mineralization is mainly associated with chloritization and silicification, while the disseminated mineralization with silicification, carbonitization, albitization and chloritization. The metallic minerals constituting mineralization are predominantly pyrite with minor amounts of chalcopyrite, sphalerite and magnetite. The pyrite occurs widespreadly in all polished thin sections, and is usually about 90 per cent of the metallic minerals in content in addition to individual specimen, e.g. Section No. 21552, in which the pyrite is about 70 per cent. In some specimen, such as Sections No. 21554, 21558, the mineralization is only consists of pyrite. The pyrite is euhedral or hypidiomorphic-granular individual or aggeragate of crystals, ranging generally from 0.05 to 0.5 mm in size, and spatially very related with chloritization. The chalcopyrite also exists widespreadly in most places where the mineralization occurs, but is low in content which is usually less 10 per cent of metallic minerals, with the exception of the Section No. 21552. which is about 20 per cent. The chalcopyrite is allotriomorphic granular, and occurs generally along the cracks or the edge of pyrites in where the pyrites are replaced by chalcopyrite. The sphalerite is often associated spatially with chalcoprite, but usually less 5 per cent in content of metallic minerals. The magnetite, with less 5 per cent of metallic minerals in content, has been recognized to occur in some specimen, such as Sections No. 21551, 21552 and 21554, and is mainly euhedral acicular individual crystal, each about 0.1 mm long, which it is oriented along the direction of schistority.

2.5 Order of Geological Events

According to the relationship of structure and texture, these bore specimen of rocks from the drilling core have been recognized to undergo, at least, three geological events in different geological times. First is the formation of primary volcanic rock series, which is probably composed of two parts of basic and acidic volcanites; Second is the event of hydrothermal alteration and mineralization, which were formed by the filling and replacement of solution produced along fissures within volcanites; Third is the event of regional metamorphism and deformation, which displays the result that, on the one hand, The fold and fault system was produced, and the metamorphic minerals, such as chlorite, occur extensively in rocks within which they are oriented along the direction of schistority, on the other hand, the recrystllization and the cataclastic texture of pyrites occur extensively in rocks, and the altered and mineralized veins are oriented along the direction of schistority, as well as the altered and metallic minerals are surrounded by schistority, which they illustrate that the event of the hydrothermal alteration and mineralization is earlier than one of the regional metamorphism and deformation.

3 Discussion

On the basis of the systematically identifying bore specimen of the drilling core, we can obtain some information with considerable worth for further investigations of ore deposits in this area.

3.1 Mineralization and Ore Deposits

Two massive sulphide deposits with considerable economic value, i.e. Gjersvik and Skorovass, have so far been known to occur within metavolcanic sequence of greenstone belt in the Gjersvik Nappe, Grong District. The Skorovass, and Gjersvik deposit, respectively, consists mainly of massive Cu-Zn sulphides with a directly underlying stockwork stringer zone of interconnected pyrite and quartz veining with associated intensive hydrothermal wall-rock alteration (A.Reinsbakken 1980, 1986). According to the result of identifying polished and polished thin sections of specimen of ores from the Gjersvik mine (The ore specimen are supplied by Prof. F. M. Vokes) under microscope, the massive ores can, at least, be divided into three types and six subtypes: 1) massive ores, consisting mainly of sulphides which are over 90 per cent in content. On the basis of the ore mineral assemblages, they can subdivided into two subtypes: a) Pyrite + Chalcopyrite, b) Pyrite + Chalcopyrite + Pyrrhotite; 2) banded ores, composed predominantly of sulphides with a small amount of magnetite, which the ore minerals rang from 60 to 70 per cent in content. According to the main ore and gangue mineral assemblages, they can be subdivided into three subtypes: c) Pyrite + Sphalerite + Chalcopyrite + Carbonate + Quartz, d) Pyrite + Sphalerite + Carbonate + Quartz, e) Pyrite + Magnetite + Carbonate + Quartz; 3) banded ores, comprising largely magnetite with minor amounts of pyrite, which ore minerals are about 40 - 50 per cent in content. The main mineral assemblage is Magnetite + Pyrite + Quartz (chert).

Owing to the fact that the drilling core, just described above, also occurs within the metavolcanic sequence in the Gjersvik Nappe,
Grong District, some questions will be further discussed on the basis of comparison of the drilling core to the Gjersvik and Skorovass deposits.

A) The mineralization exposed in the drilling core is characterized by non-homogeneous vein and disseminated sulphides controlled obviously by fissures with associated intensive hydrothermal wall-rock alterations of chloritization, silicification, carbonitization and albitization. In comparison with the Gjersvik and Skorovass deposits, this kind of mineralization may represents a part of massive sulphide deposit, that is, feeder zone directly underlying massive body.

B) The minerilization discovered within the drilling core supplies a considerable clue for further seeking majority of massive sulphides in the area although it is non-economic value by itself in both content and size. That is, the massive sulphide body, which is directly overlying feeder zone, has become a target to be further investigated. Thus, it is probably important to research detailingly the types of hydrothermal wall-rock alterations assiociated with the feeder zone and their distribution as well as the relationship between them and wall-rock in space.

C) The pyrrhotite is not found among sulphides in the drilling core, while the Gjersvik deposit is characterized by associated with, but the Scorovass without pyrrhotite. What relationship among them is interested.

3.2 Fossil Hydrothermal System

A massive sulphide deposit represents a fossil hydrothermal system which was produced on and near surface of ocean floor. The mineralization discovered in the drilling core is closely associated with hydrothermal wall-rock alterations, of which silicification and carbonitization are two dominant types. The gangue minerals associated with massive and banded ores in the Gjersvik deposit are predominantly quartz and carbonate. If they are both considered as the production of a hydrothermal system, the former represents the phase of feeder zone formed by metasomatism of solution within the earth's crust near ocean floor, while the latter the phase of massive ores formed by precipitation on the ocean floor. This similarity of compositions of gangue and ore minerals (i.e. quartz, carbonate and pyrite, chalcopyrite, sphalerite) between feeder zone and massive bodies may exhibits the trend that the composition of solution moving from feeder zone to sedimentary environment of ocean floor is alike. Thus, it is worth to study systematically relationship between mineralization and hydrothermal alteration associated with feeder zone, and gangue and ore minerals and chemical sediments associated with massive bodies by means of geochemistry of trace elements or inclusion.

3.3 Metavolcanites

3.3.1 Due to the fact that highly porphyritic nature is a characteristic feature of island-arc volcanic rocks in which plagioclase is usually the most abundant phenocryst phase (Ewart 1982, Wilson, M. 1989), It is considered, to certain extent, as a posibility that the metavolcanites with metaporphyritic texture in the drilling core, may originally be formed in paleo-island arc.

3.3.2 Owing to the facts that the metavolcanites covered in the drilling core consist mainly of metamafic rocks with minor amounts of metafelsic rocks and that the meta-amygdales, which fumarole and amygdaloidal textures are usually developed in the upper level of near surface of volcanic sequence, occur extensively in metamafinites, the metavolcanic sequence might has been considered as a transitional zone from metamafic to metafelsic rocks.

3.3.3 It has been recognized that the main ore-bodies with considerable economic value in the Skorovass and Gjersvik deposits occur within the metafelsic succession of the metavolcanites (A. Reinsbakken 1980, 1985), while the mineralization found in the drilling core exists predominantly in metamafic, lessly in metefelsic succession. Thus, an interesting question is that what relationship is among metamafic and metafelsic rocks and mineralization.

3.3.4 The names of the metavolcanic rocks have preliminarily been given on the basis of main mineral assemblages and textures. However, the material of rock-chemical analysis and occurrence of rocks in field are requested if their names would be precisely determined.

3.3.5 It becomes important to carry out the researching work of geochemistry of some trace, rare elements and stable isotopes in order to further determine the paleotectonic setting, origin of metavolcanites where the mineralization occurs, and relationship between mineralization and metavolcanites.

4 Deformation

Owing to the fact that the mineralization is earlier than the regional metamorphism and deformation, the occurrence and distribution of ores have been, in greatly extence, determined by the developing level and styles of tectonics. Therefore, it is very important to determine the relationship between mineralization and structures.