Chapter 4 Integrated Discussions on Survey Results

4-1 Characteristics of Geological Structure and Mineralization

The survey area is in the coast of the Black Sea in the Republic of Turkey, and geologically situated in the northeastern Pontides.

4-1-1 Tunca Area

(1) Geology and Geological Structure

The rocks in this area are of the upper Cretaceous Alemağaç, Çağlayan, and Sivrikaya Formation, and the Tertiary Hamadiya Formation from the bottom The Alemağaç Formation is the lowermost formation in the area, being extensively distributed in the eastern Pontides. The formation is correlated with the Kızılkaya Formation, which is the common ore-host formation for the volcanogenic massive sulfide deposits, and is composed of the dacite lava (Adcl), dacitic pyroclastic rocks (Atf), purple dacite (Adcp), green dacite (Adcg), and its pyroclastic rocks (Attf). The dacite lava (Adcl) is distributed centering Muskale Mountain to the south of the area, and forms lava dome. The dacitic pyroclastic rocks (Atf) have been formed by phreatic explosion occurred on the flank of the lava dome. The purple dacite (Adcp), green dacite (Adcg), and its pyroclastic rocks (Attf) are essentially same products from the activity right after the phreatic explosion, and its intrusive facies, lava facies, and clastic rock facies are correlated to the purple dacite, green dacite, and its pyroclastic rocks respectively. The Çağlayan Formation is characterized by its dominant basic volcanic activity, and thick basaltic lava overlies the reddish calcareous mudstone layer in the bottom. The intrusive dacite and dolerite are scattered in the area everywhere.

(2) Mineralization

The ore deposit and occurrences in the area are all of the volcanogenic massive sulfide type.

(a) Ore Horizon

It is presumed that the volcanogenic massive sulfide mineralization is related to the hydrothermal activity cased by phreatic explosions on the flank of the dacite lava dome (Adcl) of the Alemağaç Formation. It is thought that the Tunca Deposit and

Tunca West Occurrence in the area have been formed by this activity. The purple dacite intruded in the stage when the activity was decaying, and the mineralization also occurred in the green dacitic pyroclastic rocks (Attf) in this stage. It is thought that the Tunca South Occurrence, Şenyuva Occurrence, and Şenyuva North Occurrence have been formed in this stage. Accordingly, the ore horizon ranges from the upper part of the dacitic pyroclastic rocks (Atf) to the lowermost of the Çağlayan Formation, where the reddish calcareous mudstone deposited. Oxide manganese ore is concentrated in the reddish calcareous mudstone around the Şenyuva Occurrence. It is possible that the manganese ore is related to the hydrothermal activity.

(b) Alteration Mineral

The alteration zone in the area can be classified into two zone; 1) quartz - sericite - (sericite/smectite mixed layer mineral) zone, 2) quartz - chlorite - sericite/smectite mixed layer mineral - (smectite) zone. The continuity of the zone is poor. It is thought that the poor continuity is due to weak mineralization activity or far from the activity center, in addition to the dominant intrusive bodies of the purple dacite in the area.

(c) Alteration Index

The alteration index (AI) is higher than 90% only in the Tunca Deposit, Tunca West occurrence, and around the Şenyuva Occurrence. However, its continuity is poor.

(3) Drilling

(a) MJTH-1

The hole has penetrated from the Çağlayan basalt lava (Cbs) to the purple dacite (Adcp) of the Alemağaç Formation. The purple dacite has undergone intense silicification, and argillization overall, containing pyrite dissemination. The uppermost of the purple dacite is also undergone significant argillization, containing pyrite dissemination. It is possible that the Şenyuva North Occurrence extends to this part. It is thought that the mineralization and alteration here are of the volcanogenic massive sulfide type.

(b) MJTH-2

The hole has caught two kinds of dacitic tuff-breccia, which has not confirmed on the surface.

The dacitic tuff-breccia (Adlh) is petrologically same as the underlying tuff-breccia (Adlf). However, they should be separated because that hematite network is embedded in the boundary between both members, and the underlying dacitic tuff-breccia (Adlf) has undergone silicification, being accompanied with a little sulphide dissemination. The tuff-breccia (Adlf) facies is resemble to that of the dacite (Adlv), being taken into the purple dacite in MJTH-1, therefore it is presumed that they are in the same series activity, and belong to the Alemağaç Formation. The overlying dacitic tuff-breccia (Adlh) has not been mineralized, but the underlying dacitic tuff-breccia (Adlh), on the contrary, has been mineralized. Therefore, the former should be the hanging wall of the ore horizon, and the latter should be the footwall of the ore horizon. The X-ray diffraction test has revealed that the footwall dacitic tuff-breccia (Adlf) contains laumontite together with quartz and chlorite, and is rich in albite. The alteration intensity is low as 13 to 40%.

(c) MJTH-3

The hole has got into the acidic pumice tuff (Attf), hanging wall of the ore horizon, at 247.2 meters, then into the dacite lava (Adcl), footwall of the ore horizon, at 260.2 meters. Both members are of the Alemağaç Formation. The acidic pumice tuff (Attf) and dacite lava (Adcl) are classified in the quartz – sericite – chlorite – (sericite / smectite mixed layer mineral) Area. However they are rich in albite, high in Na content, and low as 27 to 58 percent in the alteration intensity except one specimen. As the result of the above, it is thought that the rocks of the hole have undergone the volcanogenic massive sulfide mineralization, but its intensity is low. It is, therefore, thought that the position of the hole might be far from the mineralization center, or the mineralization itself is weak.

(4) Tunca Deposit

The Tunca Deposit is situated on the north bank of the Tunca River, and composed of several blocks of massive sulfide ore. The deposit is in the edge of the "Tunca Landslide", having been slipped down from the cliff behind Tunca Village. It is presumed that the ore has been transferred from its assumptive source ore body, and

its source would be in between the mineral outcrop on the northern bank of the river and MJTH-2 hole. Judging from the state of the mineralization and alteration in MJTH-2, it is hard to expect a large-scale ore body in the north, but there is a possibility in the east.

4-1-2 Murgul Area

(1) Geology and Geological Structure

The rocks in the area are of the lower Cretaceous Kabaca Formation, the upper Cretaceous Murgul, Ardiç, and Küre Formations, and intrusive rocks such as andesite, dolerite, and granitic rocks.

The Kabaca Formation is the lowermost in the area, consisting of basic volcanic rocks. The Murgul Formation is divided into the lower member consisting of dacite lava and dacitic pyroclastic rocks, and the upper member consisting of pumice tuff and fine-grained tuff. Dominant rocks of basic volcanic activity, being accompanied with sedimentary rock, characterize the Ardiç Formation. The Küre Formation is distributed in the northern area, being composed of sedimentary rock. The Karatepe Dacite has intruded into the Murgul and Ardiç Formations, and overlies the upper part of the lower member's basic volcanic rocks of the Ardiç Formation as pyroclastic facies. The granitic rocks are distributed in the watershed of the Kokolet River as stocks.

East to west trend structural system is dominant in the area. The fault extending east-northeast to west-southwest and bounding the Murgul Formation and Ardiç Formation is one of the systems.

(2) Mineralization

(a) Ore Horizon

The area is divided into the Kokolet area, the Ardiç area and Kabaca area, and the altered and mimeralized dacite bodies are spread over in the area. The survey has been performed concerning the continuity of the geological state, and its stratifigraphy has been confirmed. The result has revealed that the all dacitic rocks belong to the Murgul Formation except the Karatepa Dacite, and the volcanogenic massive sulfide mineralization has occurred in the lower member's dacitic rocks of the Murgul Formation. The Murgul Formation is correlated to the Kızılkaya Formation, which is the host rocks of the volcanogenic massive sulfide ore deposits in the eastern Pontides,

and also correlated to the Alemağaç Formation in the Tunca area.

(b) Alteration Mineral

The quartz-kaolinite-sericite zone has been recognized in the volcanogenic massive sulfide mineralization center, extending to the northeast to southwest through the Çakmakkaya Deposit toward Kızılkaya. The quartz-sericite-chlorite zone appears in the west side of the alteration zone, and the quartz-sericite- (sericite/smectite mixed layer mineral) zone in the east side. The reason of the asymmetrical distribution of the alteration zoning from the axis of the mineralization center is not clear.

(c) Alteration Index

The alteration intensity zone, 90 % <AI, is distributed from the watershed of the Lepüskür River in the Kabaca Area to the south of the Çakmakkaya Deposit, and in the Ardiç area apart from the Murgul Deposit swarm. It is thought that these zones continuously connect. In the northern Kokolet area, the high intensity zone over, 80 to 90 % AI, extends to the west zone, where the Ardiç Formation overlies. It is said that the alteration intensity zone in the Ardiç area extends toward the Kokolet area. It is, therefore, presumed that the strong alteration intensity zone extends continuously from the watershed of the Lepüskür River to the mountain between the Ardiç area and Kokolet area, trending northeast to southwest. The intensity abruptly changes in short distance, reflecting intensity of the mineralization.

(d) Geochemical Survey

The geochemical survey result has revealed that many geochemical anomaly Areas of Au, Ag, As, Cu, Pb, Sb, and Bi are concentrated in the Kızılkaya Occurrence. A Bi anomaly has been detected in the Karagöl Occurrence, and some Ba and Mn anomaly in the Kokolet Occurrence.

(e) Mineral Occurrence

The main mineral occurrences in the area are the Lepüskür, Karagöl, Kızılkaya, Upper Kokolet, and Lower Kokolet. It is possible that all occurrences except the lower Kokolet are of volcanogenic massive sulfide type. The Lepüskür and Karagöl Occurrences are situated nearby the Çarkbaşı Ore Deposit. Dardanel Company has

conducted a drilling program for the Karagöl Occurrence, and a surface-prospecting program for the Kızılkaya Occurrence targeting gold. Two neighboring occurrences exist in the Kokolet Occurrence, the Upper and Lower. The Upper Kokolet Occurrence is a layered ore body, consisting of barite and dolomite in the uppermost of the lower member of the Murgul Formation. Followings are negative elements for the potential of the occurrence; a) the ore contains dolomite, b) the assay result is low as 0.15 g/t Ag, c) the occurrence possibly associated with the andesite intrusive. It is, however, also possible that the occurrence is of barite ore, being associated with the volcanogenic massive sulfide mineralization. The distribution of these occurrences generally extends northeast to southwest.

4-2 Potential for New Ore Deposit

4-2-1 Tunca Area

The volcanogenic massive sulfide mineralization in the area is associated with a hydrothermal activity due to the phreatic explosion on the flank of the dacitic lava dome (Adcl) of the Alemağaç Formation. The Tunca Deposit and Tunca West Occurrence are of this type. In the decaying stage of the hydrothermal activity, the purple dacite has intruded, and mineralization has occurred in the green dacitic pyroclastic rocks (Attf). This process has formed the occurrences of Tunca South, Şenyuva, and Şenyuva North.

The mineralized alteration zones are distributed around the ore deposits and occurrences, but poor in continuity. This is possibly due to its weak mineralization activity or its far position from mineralization center, in addition to the existence of many purple dacite intrusive bodies. In the drilling survey, every hole has captured some alteration zones associated with the volcanogenic massive sulfide mineralization and sulfide dissemination, however it is weak. This state is just same as that on the surface. In case of the zone is situated around postulated mineralization center, the most important thing is the position of the postulated mineralization center. It is hard to say west, because of significant purple dacite intrusive bodies. Also it is less hopeful to say north, due to the geological state of MJTH-2. It is difficult to think that the mineralization center is to the south of the Tunca River, because the Tunca Deposit is of accidental ore transferred from the north by a landslide. Eventually it is supposed that supposed mineralization center should be to the northeast to east of the Tunca

Deposit.

In summary, the potential for the large-scale volcanogenic massive sulfide deposit is low, however some possibility remains to the south of the Tunca Deposit.

4-2-2 Murgul Area

The mineralization in the area is of the volcanogenic massive sulfide type, being hosted in the Murgul lower Member. The survey for the mineralization and alteration in the area has brought following knowledge.

1. The central part of the mineralized alteration zone is the quartz-kaolinite- sericite zone, and extends to the northeast to southwest or north-northeast to south-southwest, continuously, through the Çakmakkaya Deposit toward Kızılkaya.
2. The strong alteration intensity zone (90 %<AI) is continuously extend to the north-northeast to south-southwest, through the Murgul Deposit swarm.
3. The mineral occurrences in the area are distributed north-northeast to south-southwest in general view. The Upper Kokolet barite Occurrence hosted in the uppermost part of the Lower Member of the Murgul Formation is situated in the northeastern end of the distribution.

The knowledge clearly indicates that the volcanogenic massive sulfide mineralization shows the northeast to southwest trend through the Murgul Deposit swarm. The ore horizon in the southwestern side of the Murgul Deposit has already eroded out, exposing the Lower Member of the Murgul Formation. Judging from the above-mentioned knowledge, there is less hope to expect some large-scale ore deposit. On the other hand, the mountain block from the Ardiç area to Kokolet area, to the northeast of this area, is composed of the basic volcanic rocks of the Ardiç Formation, overlying the ore horizon. It is, therefore, possible to expect some large-scale volcanogenic massive sulfide ore deposit underneath the cover rocks.