Part II

Details of the Surveys

Part Ⅱ Details of the Surveys

Chapter 1 Geological Survey

1-1 Survey Area

Fig. 1 shows the location of the survey area. The Hopa area is situated in the northeast of the Turkey, near the border with the Republic of Georgia. For fiscal 2003, The Tunca area and Murgul area were selected for the survey. The Tunca area is situated in the southwest of the Hopa area and the Murgul area is situated in the east of the Hopa area.

1-2 Survey Method

(1) Field Survey

The geological survey in the field has been performed along route lines set up for the survey, after study of existing geological data. Topographic maps scaled 1:2,500 (Tunca area) and 1: 10,000 (Murgul area) were enlarged from existing maps scaled 1 : 25,000 have been provided for the field survey. GPS has been utilized for the field survey. Specimens for all typical rocks and rock facies have been taken with sufficient cares.

(2) Specimens and laboratory tests

The laboratory tests included thin section observation, polished section observation, whole rock analysis, X-ray diffraction, ore grade analysis and lead isotope.

1-3 Survey Results

1-3-1 Tunca Area

The Tunca area is situated in the southwest of the Hopa area. The area is from 300 meters to 900 meters in altitude along the Tunca River basin, covering 6 km^2. The topography is rough and steep, and there is little flat land. The drainage patterns are well developing along the Tunca River, which flows west from the east in the south of the survey area. A number of streams flow into the Tunca River, including the Beyazsu River and the Şenyuva River. The quantity of flow is abundant and it makes steep valleys. The Tunca River divides the survey area into two major parts. The northern part has sparse houses and tea plantations expand in the southern slopes. Meanwhile, the southern part is steep slope to the Muskale Mountain in pathless primeval forests.

There are settlements, such as Tunca, Nobahule, Duz, and Şenyuva, in the area. Houses are sparse in steep slopes. The Tunca village, center part of the survey area, is on the landslide zone, which has slipped down from the cliff just behind the village.

(1) Geology

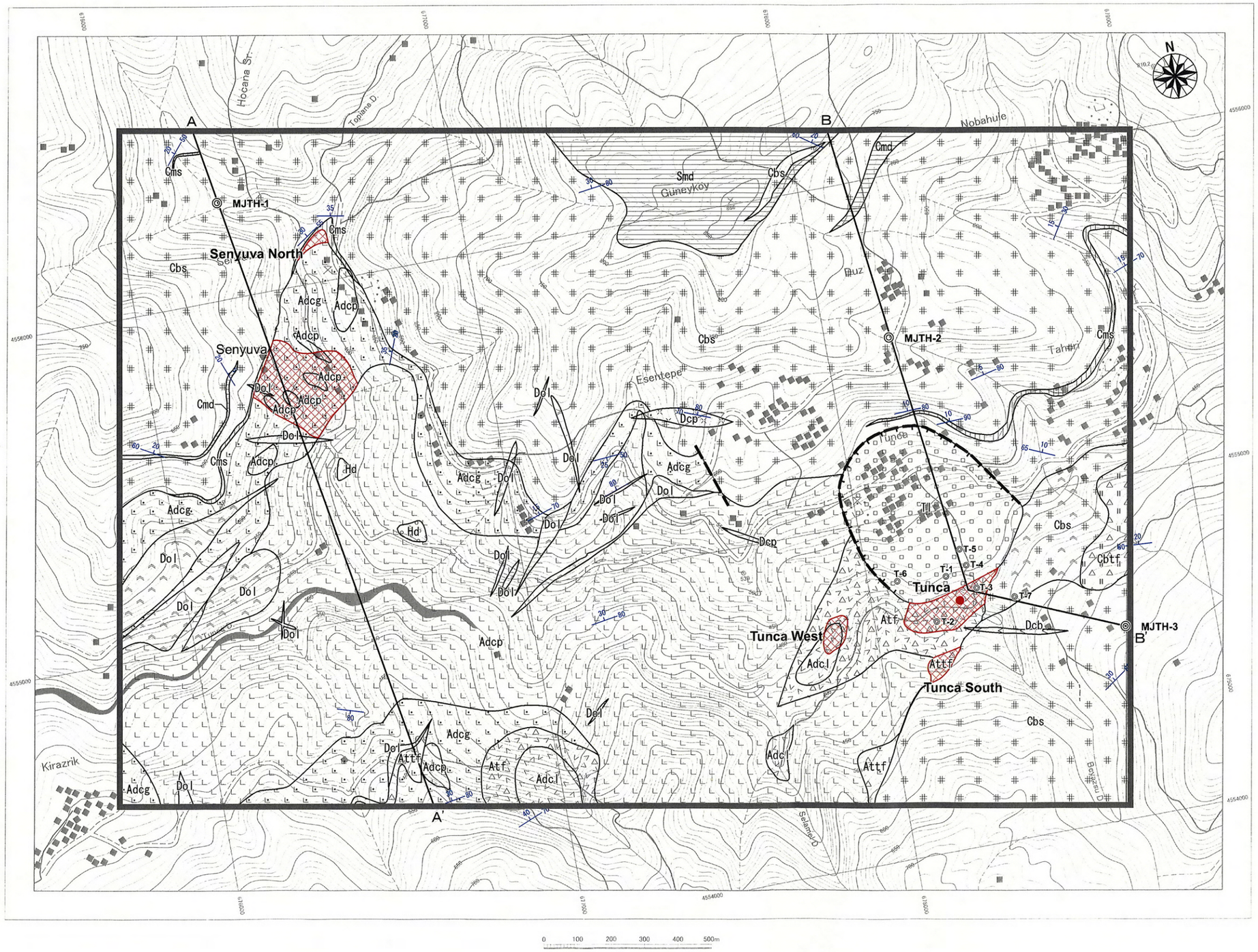
The survey area is underlain by the Alemağaç, Çağlayan, and Sivrikaya Formations of the upper Cretaceous, and the Hamidiya Formation of the Tertiary in ascending order, and several rocks have intruded into these formations. Fig. II-1-1 shows a geological map, Fig. II-1-2 shows a geological profile and Fig. II-1-3 shows a schematic stratigraphic map.

(a) Alemağaç Formation

The Alemağaç Formation is the lowermost formation in the area, and is composed of the dacite lava (Adcl), dacitic pyroclastic rocks (Atf), purple dacite (Adcp), green dacite (Adcg), and its pyroclastic rocks (Attf). The formation is extensively distributed in the southern part of the area.

The dacite lava and dacitic pyroclastic rocks are distributed around the Tunca Deposit and to the east of Kirazlık. The dacite lava (Adcl) is distributed centering Muskale Mountain (height 903 meters) 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 dacite lava is generally aphyric, consisting of minor amounts of quartz and plagioclase phenocrysts and is remarkable in its autobrecciated structure. It is difficult to distinguish dacite lava from its pyroclastics rocks at the upper position. The dacitic pyroclastic rocks are abundant in vicinities of Bayırcık to the west of the survey area, but their distribution in the survey area is restricted. The dacite lava and the dacitic pyroclastic rocks have undergone volcanogenic massive sulphide mineralization and intense silicification.

The purple dacite (Adcp), green dacite (Adcg), and its pyroclastic rocks (Attf) are extensively distributed to the south from the center of the Tunca area. The Purple dacite is intrusive rock showing light purplish gray. It is distributed from the east of the Tunca Deposit to the Şenyuva River along the Tunca River and columnar joints are remarkable. The purple dacite is aphyric similar to the dacite lava (Adcl), therefore



Legend

Land Slide
- Tl — Talus

Intrusive Rocks
- Dcp — Porphyritic Dacite
- Dcb — Biotite Dacite
- Dol — Dolerite

Hamidiya Formation
- Hd — Sediment

Sivrikaya Formation
- Smd — Mudstone

Çağlayan Formation
- Cmd — Mudstone
- Cbtf — Basic Tuff
- Cbs — Doleritic Basalt
- Cbs — Basalt Lava
- Cms — Calcarious Mudstone

Alemağaç Formation
- Attf — Dacitic Pyroclastics
- Adcg — Green Dacite
- Adcp — Purple Dacite

Purple Dacite

- Attf — Dacitic Pyroclastics
- Adcl — Dacite lava
- 20 / 80 — Strike and Dip
- Fault
- Occurreuce
- Massive Sulphide
- Drilling point
- A——A' Cross Section Line

Fig. Ⅱ-1-1 Geological Map of the Tunca Area

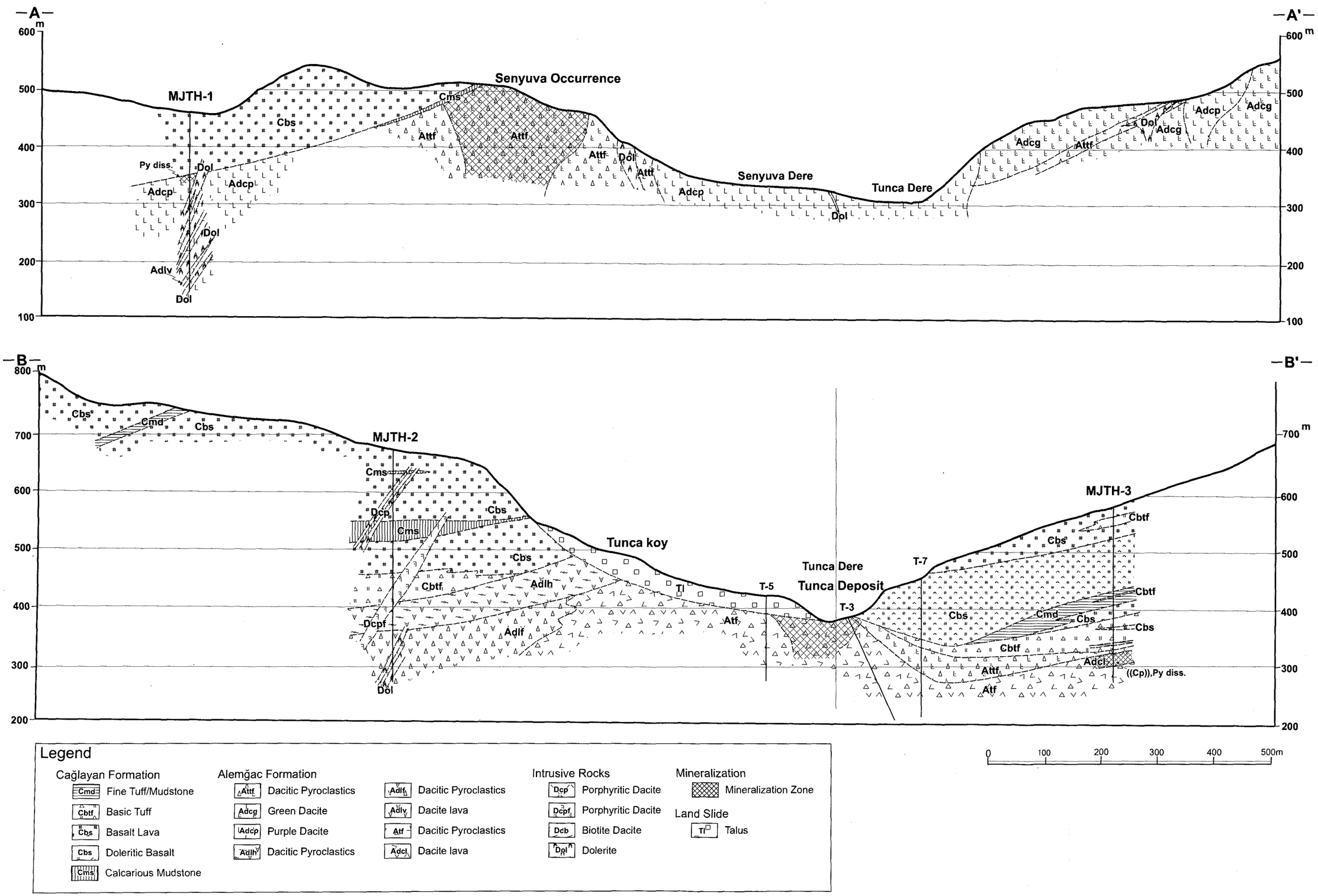


Fig. Ⅱ-1-2 Geological Cross Section of the Tunca Area

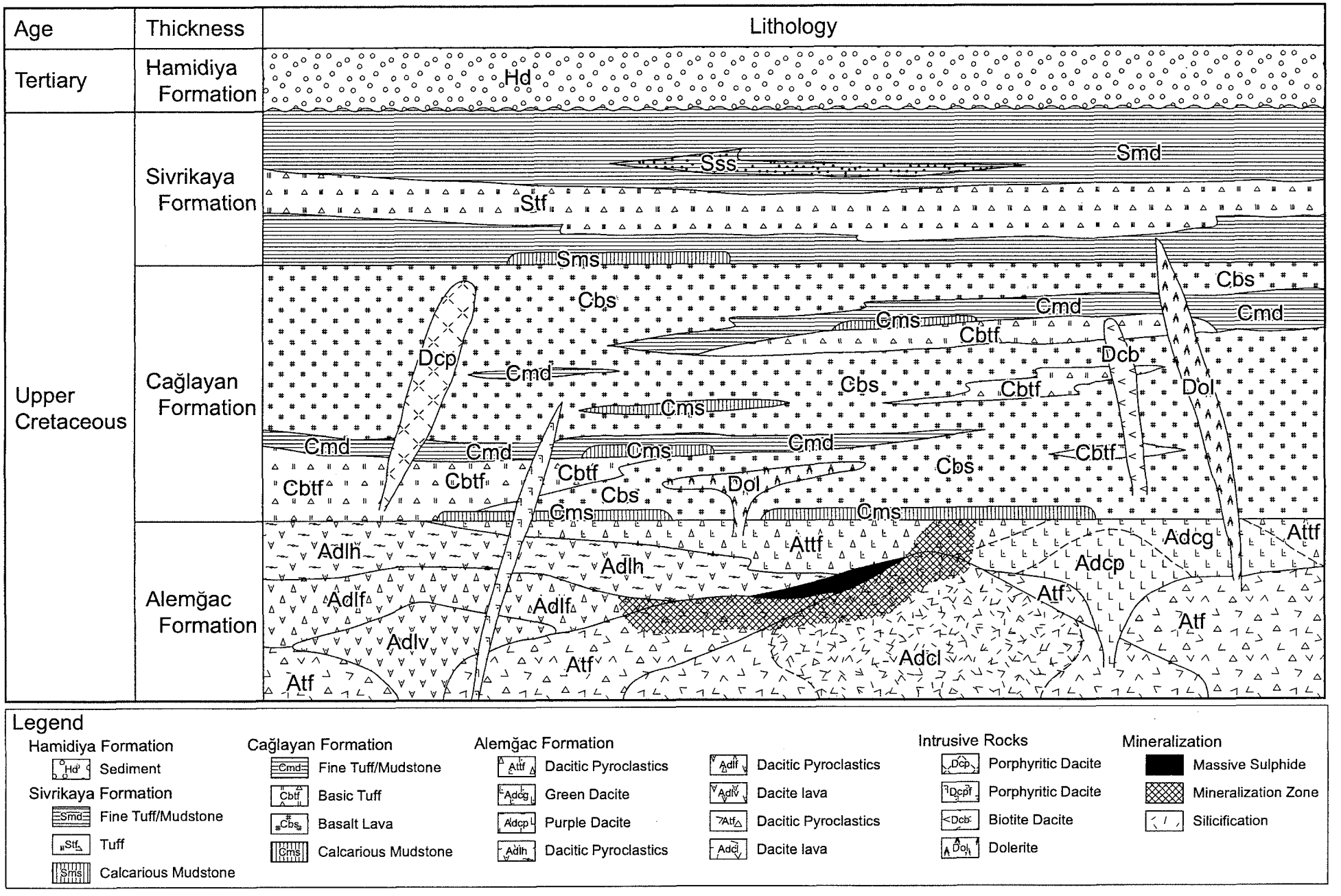


Fig. Ⅱ-1-3 Schematic Stratigraphic Column of the Tunca Area

they are difficult to differentiate when altered into white color. The green dacite and its pyroclastic rocks are distributed from Esentepe to the upper stream of the Şenyuva River, and to the west.

The green dacite is green to light green rocks in lava facies with dark green flow band. The green dacite gradually changes to its pyroclastic rocks in the margin of the bogies. The ends of the green dacite are dissimilated into pyroclastic rocks, which have white spots in the dark green groundmass. The dacite has undergone mineralization, producing pyrite and a small quantity of chalcopyrite and galena disseminations, and being accompanied with silicification and argillization near of the Şenyuva River (Şenyuva Occurrence). The Tunca South Occurrence, which is to the south of the Tunca Deposit, is consists of sphalerite, galena and barite disseminations. This occurrence is also embedded in the green dacitic pyroclastic rocks. The green dacite and the purple dacite are distributed closely and their boundary is in transition. These evidences suggest that the purple dacite (Adcp), green dacite (Adcg), and green dacitic pyroclastic rocks (Attf) are essentially same products, and its intrusive facies, lava facies, and clastic rock facies are correlated to the purple dacite, green dacite, and its pyroclastic rocks respectively. In the decaying stage of the hydrothermal activity right after the phreatic explosion stopped, the purple dacite intruded. Then, it is presumed that the mineralization occurred in the green dacitic pyroclastic rocks.

[Microscopic Observation]

Dacite lava(Adcl) : Contains a small quantity of plagioclase phenocryst. Groundmass shows cryptocrystalline texture, consisting of quartz, plagioclase, and glass. Intense alteration produces quartz, calcite, chlorite, and sericite.

Dacitic lapilli tuff (Atf) : Contains mainly dacite fragments and volcanic ash, and a small quantity of quartz and plagioclase fragments. The dacitic lapilli tuff has undergone alteration, producing quartz, sericite, chlorite, and iron hydroxide.

Purple dacite (Adcp) : Contains a small quantity of plagioclase phenocryst. Groundmass shows cryptocrystalline texture, consisting of mainly quartz, feldspar and glass. Alteration produces quartz, and chlorite.

Green dacite (Adcg) : Contains a small quantity of quartz, plagioclase phenocrysts. Groundmass shows hyalopilitic texture, consisting of glass only.

Green dacitic tuff breccia (Attf) : Contains aphyric dacite fragments. Matrix consists

of volcanic ash, including hipidiomorphic to xenomorphic quartz fragment. Alteration produces quartz, sericite, chlorite, and pyrite.

(b) Çağlayan Formation

This formation is extensively distributed in the northern Tunca area and exposed to the south of Tunca Deposit.

The Çağlayan Formation is composed of reddish calcareous mudstone (Cms), basalt lava (Cbs), basaltic tuff (Cbtf), and acid tuff (Ctf). The formation is characterized by its dominant basic volcanic activities, and thick basaltic lava overlies the reddish calcareous mudstone layer in the bottom.

The calcareous mudstone layer overlies the Alemağaç Formation. The thickness of the layer is variable, range from several centimeters to several meters. In the vicinities of the purple dacite dominated area, the layer sometimes becomes thin or lacks. The layer concentrates oxide manganese ore in the southwest of Şenyuva.

There are several reddish calcareous layers, which are identical with the bottom layer, in the basalt lava. It is estimated that each layer continues varying its thickness. But it is impossible to correlate each other because they look similar and sometimes occur as lens. There exists a thick reddish calcareous mudstone layer in the basalt lava near Tahori. Its thickness exceeds 20 meters, being accompanied with thin layers of acidic tuff. It can be traced from Tahori to north of Tunca village over 1 km.

Basic volcanic rocks consist of mainly basalt lava, being accompanied with basaltic andesite. All the basalt lava beds, colored in burned umber to dark green, indicate amygdaloidal structure. Pillow lava exists everywhere in the beds, and the gas cavities are filled with calcite and zeolite. Mudball is often observed just above the reddish calcareous mudstone layer. Basaltic lavas are estimated to have erupted intermittently from multiple points throw ages. They have many facies, but it is impossible to distinguish each other. Basaltic tuffs expose extensively and intercalate thin layer of the reddish calcareous mudstone in the east end of the survey area. This rock is composed of dark green tuff breccia to lappili tuff, consisting of basaltic rubble and volcanic ash.

[Microscopic Observation]

Reddish calcareous mudstone (Cms) : Contains foraminifera fossils and mud. Mud,

containing hematite, is dominant

Basalt(Cbs) : Consist of plagioclase and olivine phenocrysts. The groundmass shows intersertal texture, consisting of plagioclase, augite, iron mineral, glass, and others. Gas cavities are filled with chlorite and calcite.

Basaltic lapilli tuff(Cbtf) : Contains subangular to subrounded basalt fragments and its volcanic ash. The groundmass has undergone alteration, producing calcite, chlorite, quartz, and clay minerals (montmorillonite+smectite).

Lapilli tuff (Ctf) : Contains of dacitic fragments and identical ash. Volcanic ash contains hypidiomorphic to xenomorphic quartz and plagioclase. Alteration causes quartz, calcite, chlorite, iron ores.

Mudstone (Cmd) : Contains mud, including a small quantity of quartz. Mudstone has undergone silicification, producing fine quartz, calcite and clay minerals.

(c) Sivrikaya Formation

This formation is distributed in the north to a further north of the survey area. The formation is composed of mudstone (Smd), sandstone and tuff (Stf). Mudstone is dominant. The mudstone shows dark gray to reddish purple in color. The 0.1 to 2 m thick mudstone is alternating with fine-grained tuff and gray sandstone in intervals of several meters. Tuffs, consisting of compact fine tuff, lapilli tuff, coarse tuff, and pumice tuff, are locally exposed.

The formation almost strikes E-W and dips north.

[Microscopic Observation]

Lapilli tuff (Stf) : Consists of dacitic fragments and coarse-grained volcanic ash, filled by fine-grained volcanic ash. Alteration produces chlorite, clay mineral (smectite+montmorillonite), iron hydroxide and others.

(d) Hamidiya Formation

This formation is the uppermost formation in the Tunca area, and unconformably overlies the lower. The formation is locally exposed and overlies the purple dacite directly in the eastern Şenyuva. The formation consists of sedimentary rocks, containing gravels such as dacite, basalt, and mudstone.

The Hamidiya Formation is presumably Miocene in age.

(e) Intrusive Rocks

Intrusive rocks, consisting of dacites (Dcp, Dcb) and dolerite (Dol), are scattered in the area everywhere.

i) Porphyritic Dacite (Dcp)

This rock is distributed in the vicinities of Esentepe in the central Tunca area. The rock intrudes into the Çağlayan basalts in the west-northwest to east-southeast. This rock is purplish gray, and rich in large quartz phenocryst.

Under microscopic observation, the phenocryst consists of idiomorphic to hypidiomorphic quartz and plagioclase. The groundmass is consists of glass. Alteration produces quartz and clay minerals.

ii) Biotite Dacite (Dcb)

Biotite dacite is distributed in the lower reaches of the Beyazsu River, west of Tunca village, and near Tahori. The dacite intrudes into the purple dacite and the Çağlayan basalts in the north-northwest to south-southeast ～ northwest to southeast with a width of several meters. The dacite is light brown and rich in pores.

Under microscopic observation, the rock appears porphyritic texture, and the phenocryst consists of plagioclase, biotite, iron minerals, hornblende, and apatite. The groundmass consists of plagioclase, potassium feldspar, silicate minerals, and others. Alteration intensity is low, producing small quantities of calcite and chlorite.

iii) Dolerite (Dol)

Dolerite, being distributed in the Tunca area everywhere, intrudes as dyke of several to tens of meter in width, and forms relatively large bodies in the vicinities of the northern bank of Tunca River in the northeast of Kirazlık. Intrusion continually occurred through ages. The rock intrudes acid tuff of the Sivrikaya Formation in the western Güneyköy. Dolerite that intrudes the Alemağaç dacite lava and the purple dacite is dominant in the north-northeast to south-southwest ～ northeast - southwest while dolerite that intrudes in the post-Çağlayan Formation is dominant in the north-northeast to south-southwest ～ north-northwest to south-southeast .

Under microscopic observation, the phenocryst consists of small quantities of