DETERMINATION OF THE ROCK MASS CHARACTERISTICS AND SUPPORT SYSTEMS OF THE NEW ULUS TUNNEL, ANKARA

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ABSTRACT

DETERMINATION OF THE ROCK MASS CHARACTERISTICS AND SUPPORT SYSTEMS OF THE NEW ULUS TUNNEL, ANKARA

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The New Ulus Tunnel will be constructed within the andesitic terrain at Hıdırlıktepe (Ankara). Excavation of the tunnel will be accomplished through blast and drill method. Emprical methods will be consulted during the design of the support systems as well as the slope of the portal rock face. Therefore it is essential to perform detailed rock mass characterization studies.

In this thesis it is aimed to determine the rock mass characteristics in order to design the rock slope of the portals and to assess the reliable support systems for the tunnel. For this purpose laboratory tests and field investigations were conducted. Field investigations involved detailed discontinuity measurements and borehole drillings. In respect of laboratory tests; point load index, unit weight and uniaxial compression strength tests were used.

The field and laboratory test results were utilized in the Rock Mass Classification Systems (RMR, Q-system) in order to ascertain the rock mass characteristics. By all accounts, necessary tunnel support systems were determined. As for the portal areas, the rock face design was accomplished through kinematical analyses. Consequently, no failure is expected at the portal rock slopes.

Keyword: Rock Mass Characterization, RMR, Q, slope design, Ulus Tunnel

ÖZ

YENİ ULUS TÜNEL GÜZERGÂHININ (ANKARA)
KAYA KÜTLESİ ÖZELLİKLERİNİN VE
DESTEK SİSTEMLERİNİN BELİRLENMESİ

Aksular, İrem
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Altındağ Hıdırlıktepe'de yapılacak olan Yeni Ulus Tüneli, andezitlerin egemen olduğu bir sahada yer almaktadır. Tünel kazısı delme-patlatma yöntemi ile gerçekleşecektir. Tünel destek sistemlerinin ve portal şevlerinin tasarımı için ampirik yaklaşımlardan yararlanılacaktır. Bu nedenle sahada ayrıntılı kaya kütlesi karekterizasyon çalışmaları yapılması gerekmektedir.

Bu tezin amacı tünel güzergâhında kaya kütlesi karakteristiklerini belirlemek, tünel portallarında şev tasarımı yapmak ve tünel için güvenilir destek sistemlerini belirlemektir. Bu sebeple gerek saha ve gerekse laboratuar verileri kullanılmıştır. Saha çalışmaları sırasında kayaçların süreksizlik analizlerine ağırlık verilmiş olup sondaj verilerinden de yaralanılmıştır.

Laboratuvar verileri olarak nokta yükleme, birim hacim ağırlık ve tek eksenli basma dayanımı verileri kullanılmıştır. Kayaç karakteristiklerini belirlemek amacıyla laboratuvar ve saha verileri sınıflama sistemlerinde (RMR, Q sistemi) kullanılmıştır. Elde edilen veriler sonucu gerekli tünel destek sistemleri belirlenmiştir. Portal şevleri kinematik analizlere göre tasarlanmıştır. Sonuç olarak portal şevlerinde herhangi bir yenilme beklenmemektedir.

Anahtar Kelimeler: Kaya Kütlesi Karakterizasyonu, RMR, Q, Şev Tasarımı, Ulus Tüneli.

To My Beloved Family

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CHAPTER 1

INTRODUCTION

1.1 Purpose and Scope

Since ancient times human beeing has always been interested in challenges between nature and himself. These challenges have mainly showed themselves in engineering problems and mostly resulted in the victory of human intelligence in the way of the creating magnificient engineering structures. The human capability has been accelarated in such a way that searching the convenient footpaths for transportation through mountains gave place to drillings into mountains for tunnel constructions.

Nevertheless it hasn't always been that much easy to construct structures within mountains. When compared with the other engineering issues, dealing with underground is obviously much more difficult and complex. The differentiations and constitutions of geological units that host the tunnels generally cause varying engineering problems. Therefore, making use of estimations has become the most effective way of finding solutions. Some of these estimations are used to accomplish the task of this study. There are two objectives of this study.The first objective is to determine the rock mass characteristics of the units located at the tunnel route and to decide the efficient support systems for "The New Ulus Tunnel". The second objective is to assess a reliable slope design for the tunnel portals.

In this scope previous researches associated with the tunnel site and the near vicinities were reviewed at first. Afterwards, detailed site investigations at the tunnel route were carried out. Following this stage laboratory tests were conducted on the specimens that were taken from the tunnel alignment.

By means of classification systems, the results gathered from both in-situ surveys and laboratory tests manifested the geotechnical characterization of the study area. According to the data derived from these studies, kinematic analyses were applied. Consequently the main problems that might be faced during slope construction were specified. The next step, generating the necessary support system, was carried out by benefitting the analyses' results.

1.2 Location and Accessibility of the Study Area

The study area is located between Hıdırlıktepe and Öncüler vicinities which are connected with Altındağ County in the North part of Ankara. According to the data derived from the satallite images (GoogleEarth Software, 2008) the New Ulus tunnel will take place between the longtitudes of N39°56′33 - N39°56′51 and the latitudes of E32°51′4 - E32°52′27. The location of the study area is presented in Figure 1.1.

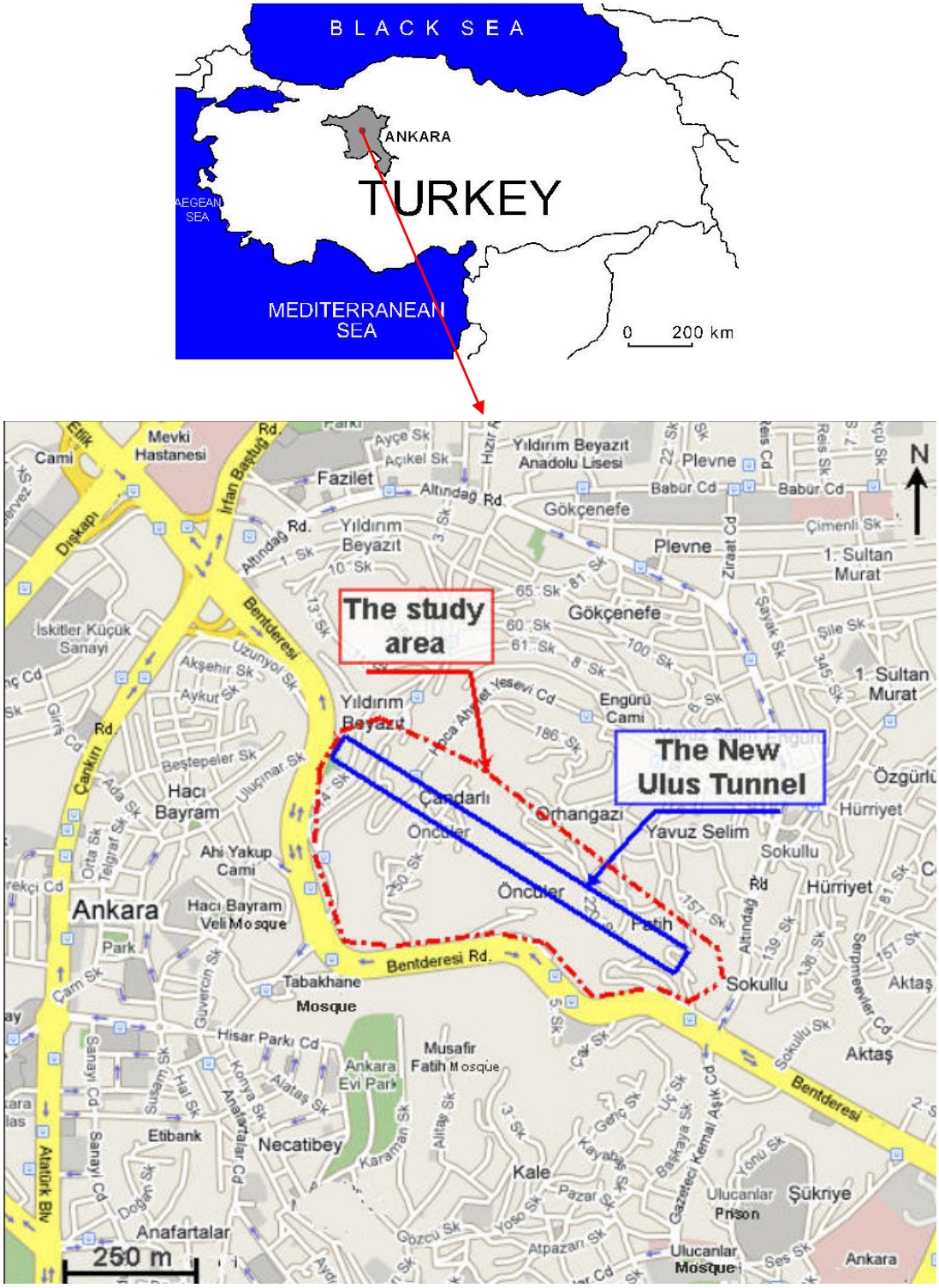

Figure 1.1 Location map of the study area is quoted from Google Map (2008)

The hill which hosts the tunnel route is surrounded by four main transportation roads which supply the connection between Ulus-Altındağ and Plevne-Fatih districts. The access to the study area is supplied by the road nets that constitude the north branch of roadway system. This branch goes through rough topography and passes at the south side of the Ankara Cidatel. The transportation branch then goes to Hipodrom's two sides and reaches to Yenimahalle and İstanbul Highway. In the close vicinity of the investigated site the roads surrounding the Citadel, Altındağ and Yenidoğan, intersect each other at different points (Kasapoğlu, 2000).

The New Ulus Tunnel's location, Hıdırlıktepe, rises between two main roads as a part of Yenidoğan district. The road that passes among the south and the west side of Hıdırlıktepe is Bentderesi Road which connects Altındağ Road with Çankırı Road and İrfan Baştuğ Road.

1.3 Tunnel Characteristics

The New Ulus Tunnel is planned to be constructed within the scope of the renovation project of Hıdırlıktepe-Bentderesi vicinities. The project is carried out by Greater Municipality of Ankara to organize a new way for Ulus-Altındağ transportation. For that purpose, starting from Sakalar place on Bentderesi road, the new transporatation route is planned to be shifted to the north, into the New Ulus Tunnel that will pass under the hill.

According to the plans, the tunnel allignment follows the topographical structure and extends nearly parallel to Bentderesi road. The 780 m long tunnel will advance in approximately 870 m elevation and end on Şehit Kaya Aldoğan Road. In consideration of the transportation route, the New Ulus Tunnel will consist of double tubes each are 9 m height. Horseshoe shape with a width of 12 m is chosen for the tunnel design. The tubes will be positioned 24 m apart from each other. Regarding to the construction method, blast and drill methods will be

applied at the construction stages. The main characteristics of the tunnel are given in the Table 1.1.

Table 1.1. The physical properties of the New Ulus Tunnel

Type	Transportation; Main Road
Location	Öncüler - Hıdırlıktepe, Altındağ in Ankara
Length	780 m
Height	8,15 m inner, 9 m outer
Width	10,6 m inner, 12 m outer
Maximum Span	12 m
Elevation	Approximately 870 m
Shape	Horseshoe shape
Number of Tube	Twin-tube tunnel with tubes 24 m apart
Construction Method	Blast and drill
Strike of Tunnel	308°

1.4 Physiography

1.4.1 Topography

Ankara has an elevation of 960 m in average and the elevation difference between the highest and the lowest places in the city is 260 m (Kasapoğlu, 2000). The tunnel construction will take place at the south slopes of Timurlenk Hill which is formed by andesites and is one of the main rises at the close vicinity. The main construction area, Hıdırlıktepe (888 m), is located on Timurlenk Hill which has an elevation of 1003 m (Kasapoğlu, 2000). At the south, on the opposite of Hıdırlıktepe, rises another hill with an alevation of 986 m. That hill, so called Castle Hill, hosts the most famous historical structure of Ankara; the Ankara Citadel. Between Hıdırlıktepe and Citadel's hill Bentderesi Valley exists. This valley extends along East-West direction and generates a thin roadway called Bentderesi Road. Unlike the andesites that formed steep hills, the alluvium of Bentderesi stays at 850 - 870 m elevations and creates a plain.

1.4.2 Climate and Vegetation

Continental climate prevails in the study area and in its close vicinities. The main charactistic of continental climate is hot and dry summers, cold and rainy winter, and are barely dominant at the site. The highest temperatures are recorded in August and the lowest ones in January. In general, the rainfall is received at winter and spring. The mean annual rainfall for Ankara is 382,1 mm (Table 1.2).

Table 1.2. Average annual climatic characteristics of Ankara (Turkish State Meteorological Service, 2008).

Annually Mean Precipitation (mm)	Annually Mean Temperature (°C)	Annually Mean Evaporization and its time (mm-month)	Annually Mean Pressure (mb)	Annually Mean Frost Day	Annually Mean Snow Covered Day
382.1	11.7	229.7/ August	913.1	83.7	32.5

Conserning the vegetation, Ankara shows a transition character between forested lands in the north and steppes in the south. Since the New Ulus Tunnel will be constructed in an urbanized field, hints of vegatation among the project area can not be easily acquired. Most of the study area is covered with artificial and concrete structures which make it difficult to observe both vegatation and geological structures that exposed on the site. At Hıdırlıktepe there are no well distributed green areas other than bushes observed here and there. Thus, as far as vegetation distribution is concerned it may be described as barren area.

1.5 Methodology

In order to achieve the purpose of this study, five stages have been carried out. In the first stage previous works related to the study area were reviewed. A database on the classification systems, tunnel support applications and slope stability was established by making use of literature surveys.

Following the first stage, detailed field investigations were performed to acquire the geological and hydrageological conditions of the study area. These investigations involved the macroscobic observations and discontinuity measurements of the exposed andesites. In respect of the discontinuity measurements, scan-line survey method (I.S.R.M, 1981) was used. Besides, eight boreholes along the tunnel route were drilled by Alkon Eng. Cons. (2008) to identify to subsurface structure. The drillings were performed in January 2008. Site investigations were accomplished by June 2008. In addition to the macroscobic observations, petrographical analyses of andesites were conducted. In order to obtain the thin sections, the core box specimens taken from the tunnel depth were used. With the help of petrographical analyses, knowledge of the mineral contents and alteration conditions were developed.

The third stage included the determination of geotechnical characterization of the andesite. In this sense, the results of scan-line surveys and laboratory tests which were applied by Efol Geotechnics Service Ltd. Co. (2008) were evaluated in the rock mass classification systems (RMR and Q system). In the context of laboratory tests, the dry unit weight, uniaxial compressive strength and point load strength index of andesites were determined. The findings of classification systems revealed the characterization of andesites that are exposed at the study area.

The fourth stage involved the assessment of portal slope stability by kinematical method.The reliable slope angles for the portal rock slopes were obtained with the help of software Dips 5.1.

In the last stage, the required support systems for the tunnel were identified. In this sense, the classification system results were used.

1.6. Previous Studies

Having an opinion of the study area is advantageous when planning the site investigations. The foreknowledge of the site provides more realistic perception about the situation that is faced at the field investigations. Hence previous works are essential. In the context of previous studies reconing and compilation stages are involved. The relevant literatures, researches, case studies and maps of the site were utilized in this thesis. Moreover literature about the classification systems and their usages were reviewed. The sources that were resorted to are given in four parts which are the relevant literature and researches about the site, the literature about the classification systems, previous reports and maps.

1.6.1. The Relevant Literature and Researches about the Site and Its Close Vicinities

There are many geological and geotechnical studies that are directly or indirectly related to the invested site. Most of these studies were consulted among this thesis to reveal a sufficient characterization of the rock mass located at the study area.

Since a comprehensive knowledge of the discontinuities of andesites is very significant, researches and bulletins including in-stu investigations and discontinuity measurement were reviewed mostly. As published literature, the study of Kasapoğlu (2000) was used.

The researches of Ulusay (1975), Kasapoğlu (1982) and Karacan et al. (1986) were also benefitted. The geotechnical studies of Aksoy (2004), Gökçeoğlu et. al, (2000), and Ercanoğlu (1997) were referred for the assessment of slope stability and geomechanical parameters of the andesites.

In order to obtain a general information about Mamak andesite and its weathering degree, the research of Kılıç and Bilgehan (1999), Kayışoğlu, Koçbay and Kılıç (1998), Koçbay and Kılıç (2006) were reviewed. The study of Topal et. al., (2006) on weathering effect on andesites geomechanical properties led this thesis.

In addition to geotechnical literature, many reports of General Directorate of Mineral Research and Exploration (M.T.A) were referred to assess the geology of the study area.

1.6.2. The Literature about the Classification Systems

In this thesis the rock mass classification systems used to determine the andesites' geotechnical characterization are RMR (Bieinawski, 1989), Q System (Barton et.al., 1974). The rearrangements and developments of these classification systems are also reviewed in the context of literature surveys.

1.6.3. Previous Reports

Between December 2007 and May 2008, Alkon Eng. Lim. Comp. performed detailed in-stu investigations for the project they have undertaken. The company made a report containing the results of in-stu surveys and laboratory tests which were applied by Efol Geotechnics. The results gathered from these studies were used in this thesis.

1.6.4. Maps

The maps of the study area were taken from the researches and reports mentioned above. Besides, the maps related with Hıdırlıktepe and Timurlenk Hill were gathered from different resources such as satallite images (GoogleMap, 2008) and General Directorate of Mineral Research and Exploration's (MTA, 1997) reports.

CHAPTER 2

GEOLOGY AND HYDROGEOLOGY

This chapter includes two sections. In the first section, geology of the site vicinity is mentioned by using existing literature. A general geological information including the geological phases forming the site visinity is involved. This section is followed by the second one under the name of "Geology of the Site Area" in which the geological and hydrogeological conditions of the study area are descibed in details. Both field observations and petrographical investigations are represented in this section. The revealed geological conditions of the units exposed at the site are used in the former stages of this thesis for the selection of the required parameters of the rock mass that will host the tunneling applications.

2.1 Geology of the Site Vicinity

In the close vicinity of the study area, volcanic rocks (Miocene), sedimentary sequence (Pliocene) and alluvium (Quaternery) are distinguished. The Mamak formation and Tekke Volcanics constitute the Miocene aged units. The younger unit of Pliocene is identified as Gölbaşı Formations (Akyürek et. al., 1982, 1984). The map presenting the geological units in the close vicinity of the study area is given in Figure 2.1. The geological map screen given in Figure 2.1. is a part of MTA's Geological Map of Ankara - F15 quadrangle which has a scale of 1/100000. The area limited with red borderline shows the close vicinity of the invested site.

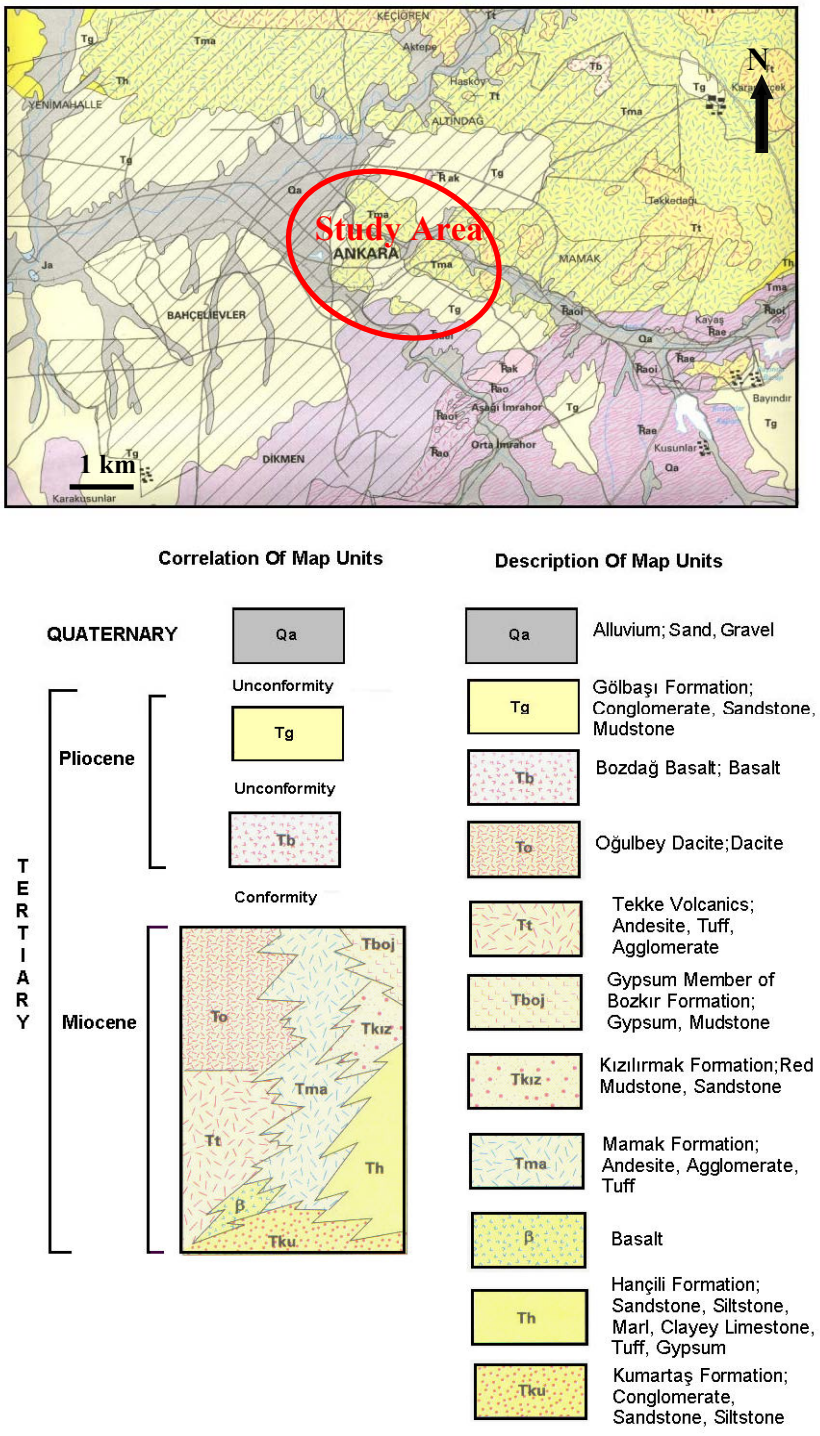

Figure 2.1 Geological map of the close vicinity of the study area (MTA, 1/100000 Scale Geological Map, Ankara Sheet)

According to the report of MTA (1997), the gelological feature exposed at the site is named as Mamak formation (Tma). The formation involves andesite, agglomerate and tuff. Agglomerates are white, gray and partly red colored and consist of andesite, dasite and basalt blocks which are embedded within a tuffaceous matrix. Some distinct beddings are observed within agglomerates. The tuffs intercalated with agglomerates are in various colors and thin bedded. Yellowish-white volcanic breccias include various sized angular andesite pebbles. A slight bedding generated by conglomerate-tuff intercalation is observed. Altough there are white and highly weathered parts exposed in the vicinity, andesites are generally gray-pink colored. In addition to the joints, flow structures on the andesites are seen in the close vicinity. Mamak formation shows transition to Kumartaş Formation and positiones laterally to Tekke volcanics and Hançili Formation. The formation is overlain by Bozdağ Basalts. It is accepted as Late Miocene aged as the units it positiones laterally. (Akyürek et al., 1997)

As mentioned in the report (1997) of General Directorate of Mineral Research and Exploration, Tekke Volcanics (Tt), first named by Akyürek et al (1982, 1984), consists of andesites, basalts, tuff, agglomerates and dasites. Pink, red and black andesites often show flow structures. The tuffs are observed as gray-white, fine grained interlayer structures between agglomerates and andesites. The formation is mostly transitional with the Mamak formation and is seen as sills in the Kumartaş and Hançili formations. The formation is assumed to occur in Upper Miocene. The unit is a product of volcanism in the continental conditions. Basalt (β) is also observed as a sublayer of the formation. Black-dark brown colored, vesiculed basalts show flow structures. They are considered as the first products of volcanism.

The Gölbaşı formation (Tg) was first named by Akyürek et al. (1982, 1984) and constitutes gray-red, slightly cemented, various sized and origined conglomerates, sandstones and mudstones. Partly horizontal beddings are observed within the units. Conglomerates consist of basalt, limestone and gabro

pebbles. Calcite and clay constitute the cementation material. The Gölbaşı formation (Pliocene) conformably overlies the Bozdağ basalts and older units.

The youngest unit exposed in the close vicinity is of Quaternery age alluvium which includes gravels and sands, silts and clays.

A generalized stratigraphical columnar section of Ankara and its close vicinities was prepared by Kasapoğlu (1980). In Figure 2.2, the modified columnar section of Ankara is given.

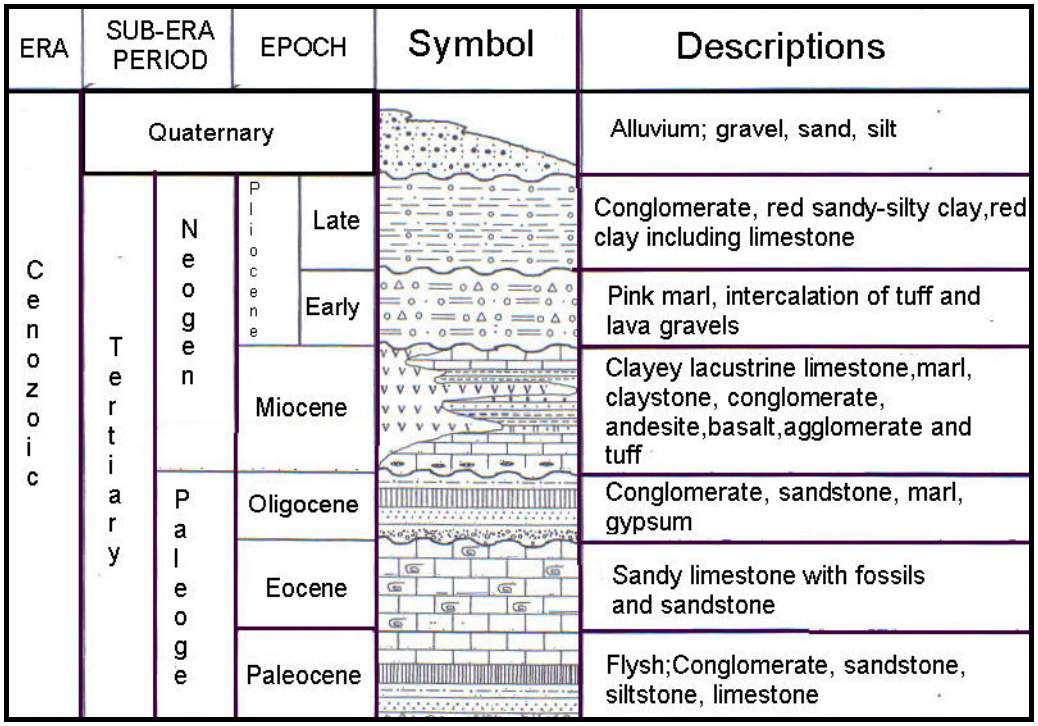

Figure 2.2 Generalized stratigraphic columnar section of Ankara (modified after Kasapoğlu, 1980).

2.2 Geology of the Study Area

The primary geological unit observed at the study area is the Mamak formation andesites (Figure 2.3). In general, the exposed andesites of Miocene age exhibit various colors and joint systems. In addition, the weathering degree of the andesites ranges between slightly and moderate. Altough the observations are so limited, the andesites showing flow structures can be identified even from a long distance. At the upper parts of the hill, these flow structures are clearly visible. In regarding to the joints, the existence of discontinuities is observable on almost all andesite outrops.

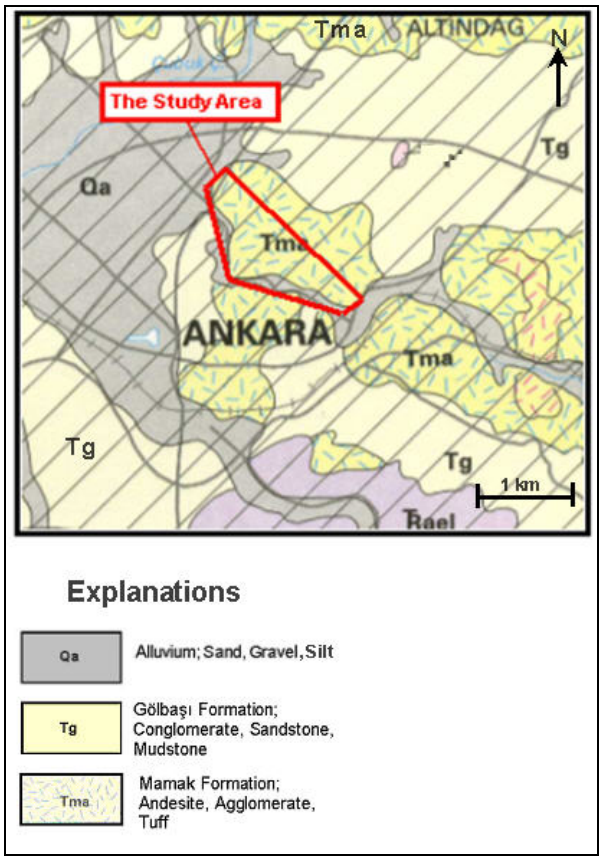

Figure 2.3 Geological map of the study area (1:500.000 reconaissence map of Turkey, Ankara-F-15 sheet, M.T.A, 1997)

2.2.1 Mamak Formation Andesites

Despite the fact that the entire hill hosting the tunnel is composed of andesites, there are very few outcrops that can be clearly observed. Most of the hill is covered with houses and artificial structures. At that point the borehole data gain significancy. In addition to the macroscobic observations, the findings of drillings were used to confirm the surface explorations. Especially at the entrance portal site there are scarcely any andesites that can be observed from the point of discontinuity measurements or assessment of macroscobic rock properties.

Under those circumstances the microscobic analyses of the andesites are consulted. For this purpose, the core boxes taken from tunnel elevation of each borehole were analized. The results are presented in the following part.

2.2.1.1 Petrographical Analyses

In addtion to field investigations, microscobic survey such as thin section of the rock material is an esset to define the rock mass conditions. Thin section is a reliable method that determines the type of rock, its origin and occurence conditions. It also reveals the external facts affecting the rock material such as water or pressure. In this thesis, thin sections of andesite specimens gathered from the cores were observed. The petrographical analyses were carried out at the Mineralogical and Petrographical Laboratory of the Department of Geological Engineering of METU (2008). In terms of petrography, excluding the core specimen 1 and 3, the core samples taken from the tunnel level were analysed to determine the geology of the tunnel allignment. The definition of the rock mass based upon the site observations was confirmed according to the pethrographical analyses. Below, the results of the analyses were presented with their photomicrographs taken under Nikon branded optical microscope with 4X magnification.

Borehole 1

Since this borehole is located near the entrance portal, the borehole data were used to identify the entrance portal's geological structure. The sample benefitted in this pethrographical analysis is a piece of the core taken from the depth between 42.00 and 43.00 metres.

Despite the fact that BH-1 does not coinside the tunnel route, the depth from which the core was taken represents the the tunnel elevation. The photograph of the core specimen used for the analyses is given in Figure 2.4. Additionally, the results of petrographical analysis of the speciemen are tabulated in Table 2.1.

Figure 2.4 The photograph of the core sample taken from BH-1.

Table 2.1 Petrographical analysis result of the core specimen (BH-1).

Borehole Number	1
Magnifying	4X
Texture	Seriate
Matrix	Glass+Plagioclase microlits+Clay
Major Minerals	Biotite, Plagioclase, Hornblende
Minor Minerals	Quartz
Observations	Biotite-hornblende (Figure 2.5, 2.6) and plagioclas (Figure 2.7) phenocrysts are seen in highly clayey matrix. Most of the plagioclase microliths composing the texture are altered. Baked biotite and hornblende crystals shown in Figures 2.5 and 2.6 indicate typical andesite characteristics

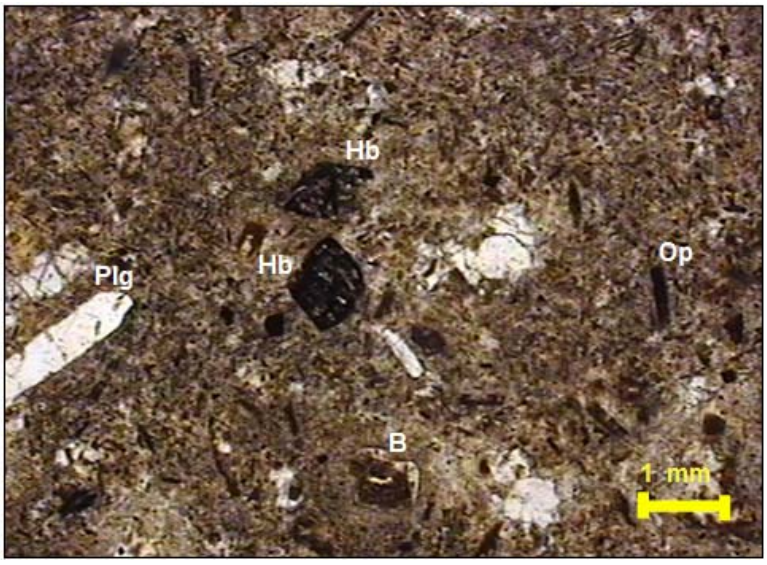

Figure 2.5 The photomicrograph of the andesite sample taken from BH-1; analyser out position under 4X Magnifying (Hb:Hornblende, B: biotite, Op: opaque, Plg: plagioclase).

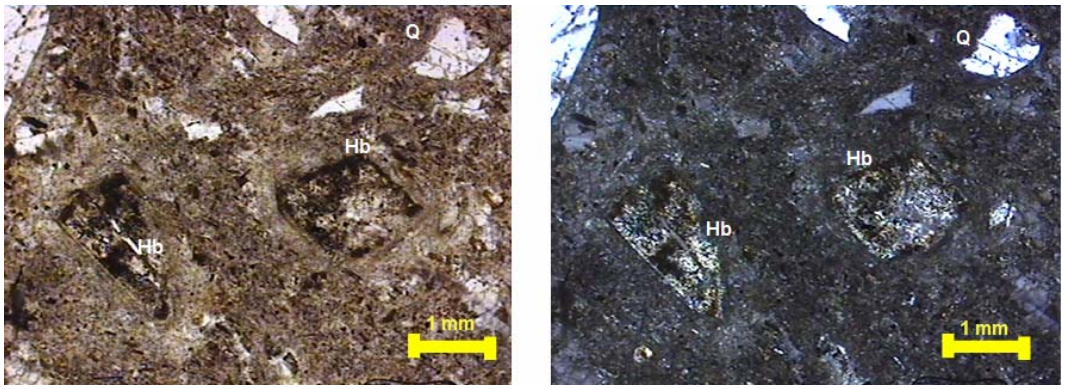

Figure 2.6 The pseudomorf hornblende crystals in both analyser out (photograph on the left) and in positions (photograph on the right). (Hb:Hornblende, Q: quartz).

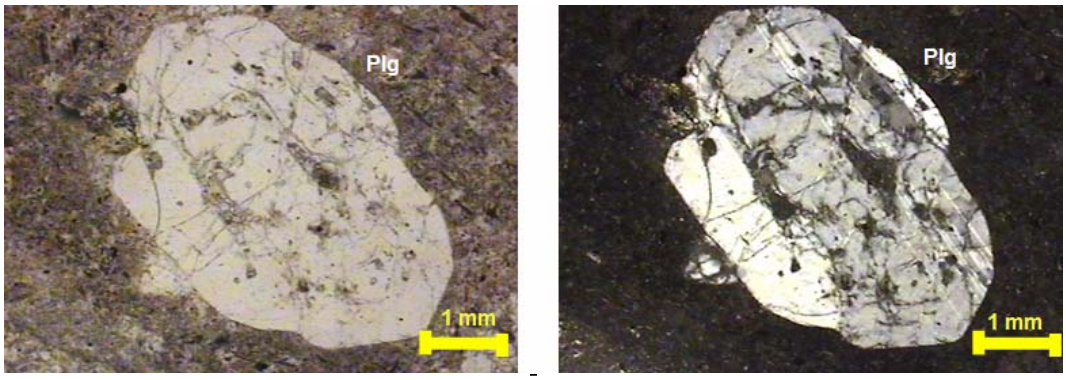

Figure 2.7 Plagioclase phenocryst (Plg) under analyser out and in positions.

Borehole 2

The second borehole was located on the left tube near the entrance portal. The core sample shown in Figure 2.8 was obtained from the tunnel elevation; between 36.60-36.76 m.

Figure 2.8 The photograph of the core sample taken from BH-2.

As seen in the figure, the pink colored specimen has aphanitic porphyry texture. The core has a length of 16 cm. The vesicules are clearly seen on the surface of the specimen. The petrographical analysis results of the specimen are given in Table 2.2. Moreover, the photomicrographs of the baked biotite crystal (Figure 2.9), the plagioclase and biotite crystals (Figure 2.10) and baked hornblende phenocryst (Figure 2.11) are illustrated below.

Table 2.2 The Petrographical analysis results of the core specimen (BH-2).

Borehole Number	2
Magnifying	4X
Texture	Seriate
Matrix	Plagioclase microlites+Clay
Major Minerals	Biotite, Plagioclase, Hornblende
Minor Minerals	Quartz
Observations	The matrix is grain supported (plagioclase microlites). Alteration prevails almost the whole thin section. Few opaque minerals were observed.

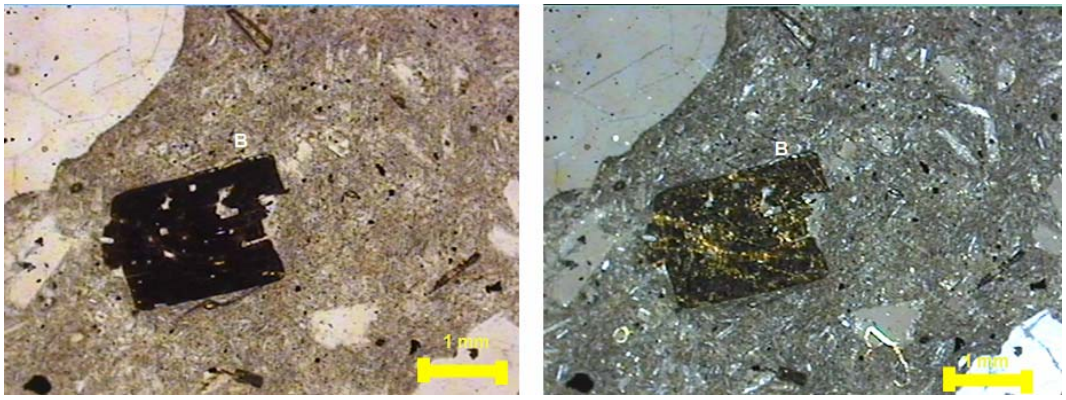

Figure 2.9. The baked biotite (B) crystal in grain supported matrix is seen under analyser out and in positions at thin section.

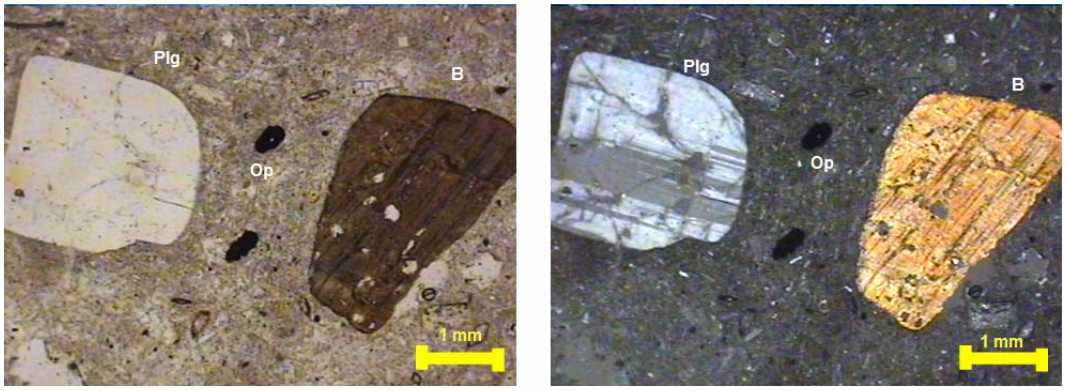

Figure 2.10. Plagioclase and biotite crystals at analyser out and in positions. (B:biotite, Plg: plagioclase, O: opaque).

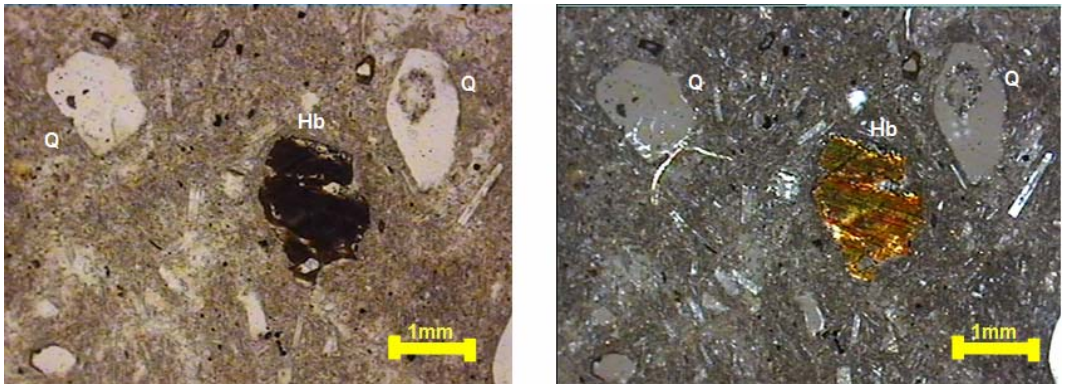

Figure 2.11 The photomicrographs showing quartz (Q) and baked hornblende(Hb) phenocryst under analyser in and out conditions.

Borehole 3

The specimen was taken from the depth between 36.00 and 36.18 m at BH-3. As seen from Figure 2.12, the 19 cm long core sample has surface staining. The petrographical analysis results of the specimen are given in Table 2.3.

Figure 2.12 The photograph of the core sample taken from BH-3.

Table 2.3 The petrographical analysis results of the specimen (BH-3).

Borehole Number	3
Magnifying	4X
Texture	Seriate
Matrix	Plagioclase microliths+Clay
Major Minerals	Feldspar, Plagioclase
Minor Minerals	Quartz, Hornblende
Observations	High ranges of opaque minerals and dense plagioclase microliths were observed. The plagioclase phenocrystals show polysynthetic twinning and zonation.

Furthermore, the photomicrographs of the baked hornblende phenocryst (Figure 2.13) and the plagioclase phenocryst in microlit supported matrix (Figure 2.14) are given below.

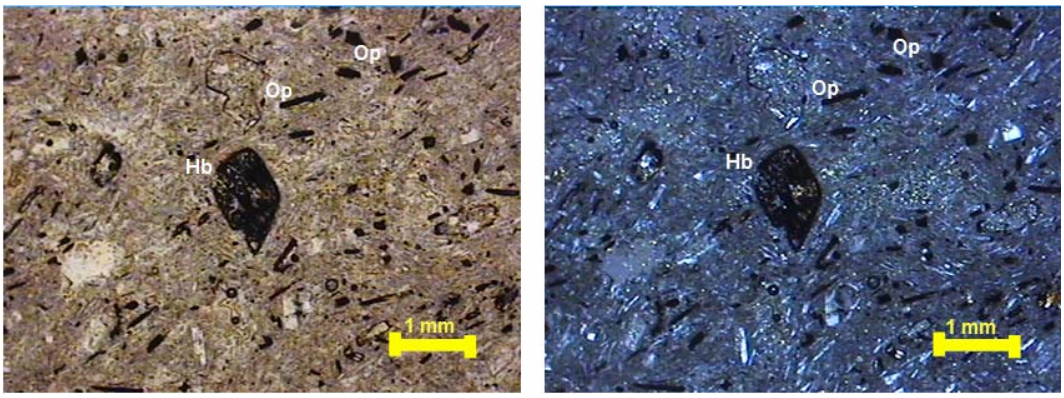

Figure 2.13 Thin section screen showing baked hornblende (Hb) phenocryst and opaque minerals (Op)under analyser in and out positions.

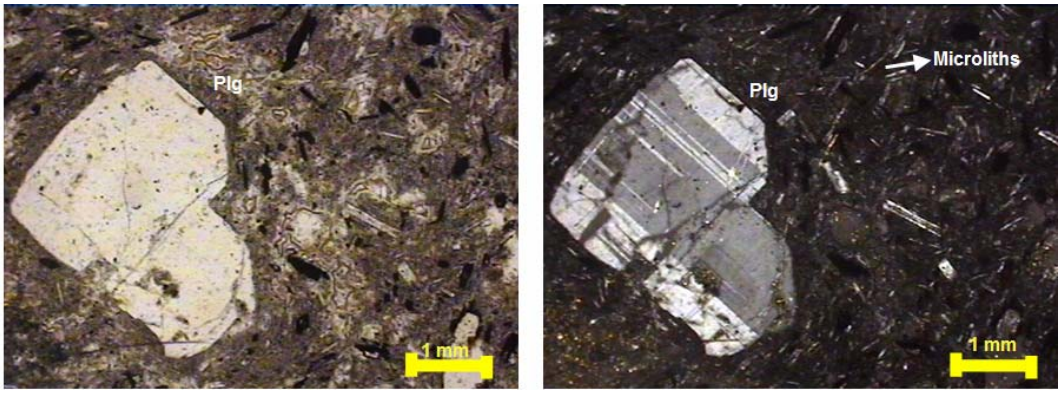

Figure 2.14 Thin section showing plagioclase phenocryst (Plg) in microlith supported matrix under analyser in and out conditions.

Borehole 4

The specimen was obtained from the tunnel elevation, at the depths of 17,50-17,65 m within BH-4 (Figure 2.15). In table 2.4, the results of petrographical analysis are given.

Figure 2.15 Photograph of altered core sample taken from BH-4.

Table 2.4 Petrographical analysis results of the specimen (BH-4).

Borehole Number	4
Magnifying	4X
Texture	Seriate
Matrix	Plagioclase microlits+Clay
Major Minerals	Feldspar, Plagioclase
Minor Minerals	Quartz, Hornblende
Observations	Highly altered (clay alteration) and oxidized andesite with vesicular structure. Baked biotites were observed. Grain supported matrix surrounds the quartz phenocrystals. Quartz phenocrystals are fissured.

Furthermore, the photomicrographs of the quartz phenocryst (Figure 2.16) and thin section of core specimen taken from BH-4 (Figure 2.17) are illustrated below. In Figure 2.17, apart from the alteration, the reddish-brown ironoxide is clearly seen under analyser out position.

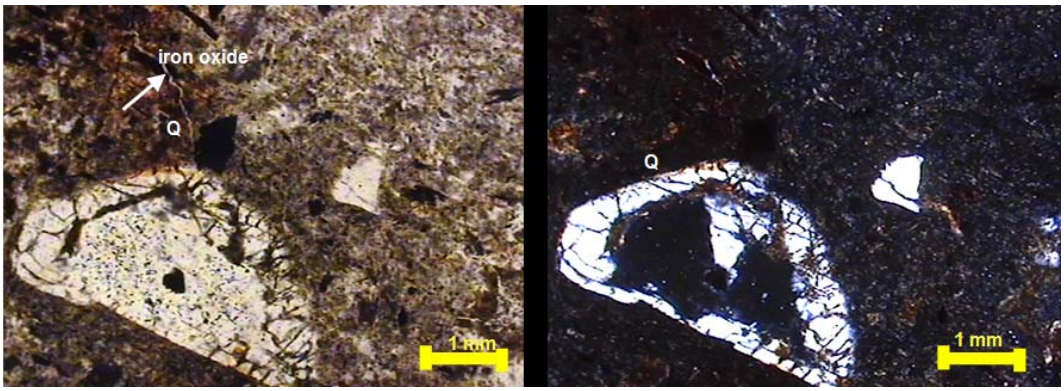

Figure 2.16 The photomicrographs of andesites showing quartz phenocryst and iron oxidation under analyser in and out conditions.

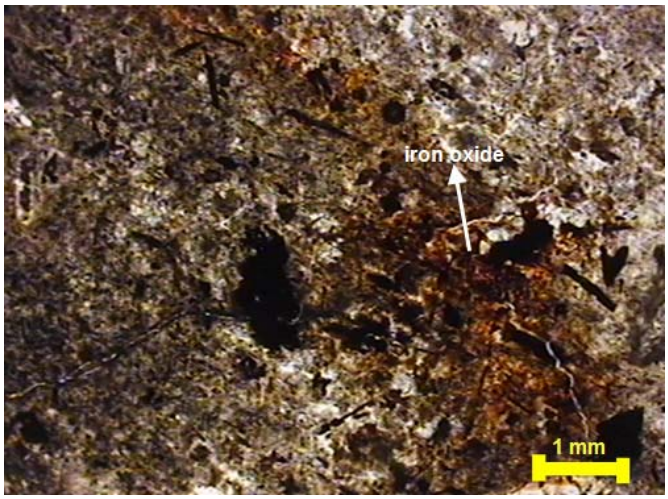

Figure 2.17 Thin section of the core specimen taken from BH-4.

Borehole 7

The specimen was obtained from the tunnel elevation, at the depths of 78,00-79,00 m within BH-7 (Figure 2.18). The results of petrographical analysis of the specimen are tabulated in Table 2.5. Additionally, the flow texture (Figure 2.19), baked biotite (Figure 2.20) crystals and plagioclase phenocrysts with pseudomorf quartz crystal are illustrated.

Figure 2.18 The photograph of the core sample taken from BH-7.

Table 2.5 Petrographical analysis results of the specimen (BH-7).

Borehole Number	7
Magnifying	4X
Texture	Glomeroporphyr+Flow Texture
Matrix	Plagioclase microliths+Clay
Major Minerals	Feldspar, Plagioclase
Minor Minerals	Quartz, Biotite
Observations	Distinct flow structure generated by plagioclase microliths was determined. In addition, baked biotites and pseudomorph crystals were observed. Quartz and plagioclase phenocrysts are surrounded by plagioclase microliths (grain supported matrix). Polysynthetic twinning of plagioclase phenocrysts were defined.

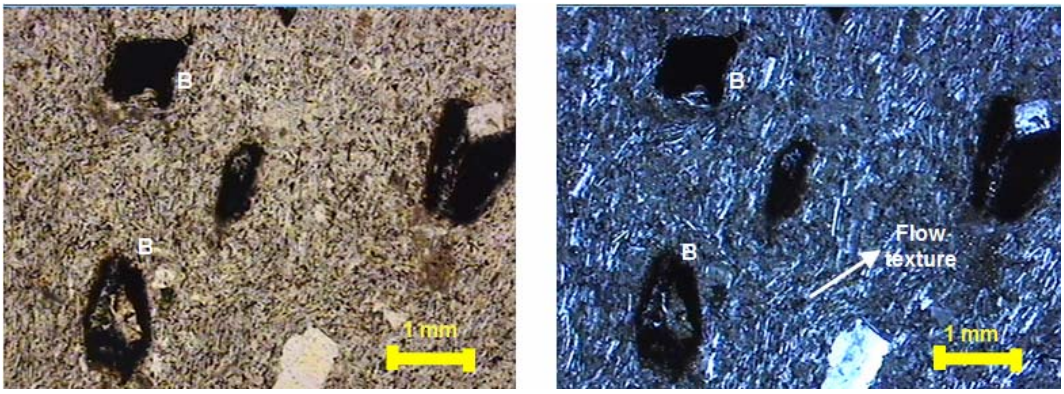

Figure 2.19 The thin section screen showing flow texture and baked biotite crystals together under analyser in and out positions.

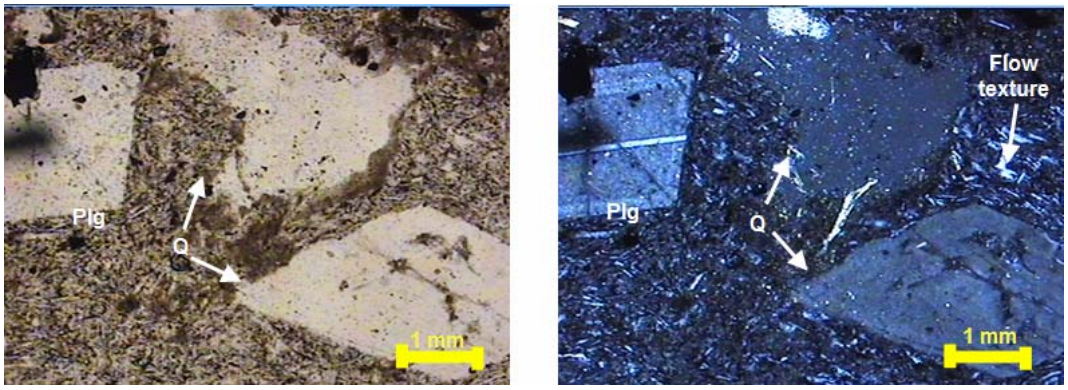

Figure 2.20. Thin section showing quartz (Q) and plagioclase phenocrysts (Plg) with pseudomorf quartz crystal (The flow texture is seen under analyser in and out positions).

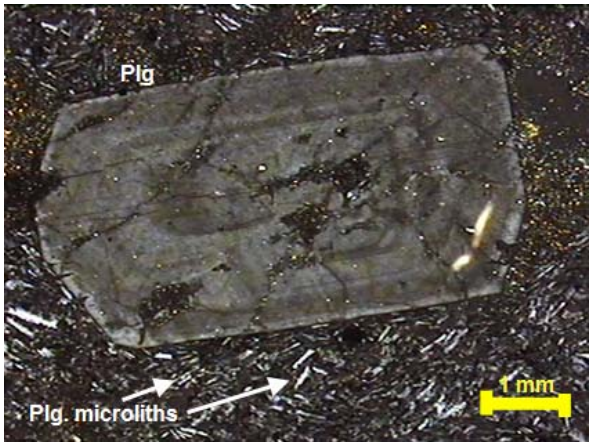

Figure 2.21 Photomicrograph of the andesite, showing the zonation of plagioclase phenocrystal (Plg) under analyser in position.

Borehole 8

The specimen was obtained from the tunnel elevation, at the depths of 34.60-34.80 m of BH- 8 (Figure 2.22).

Figure 2.22 The photograph of the core sample taken from BH-8.

The petrographical analysis results of the specimen taken from BH-8 are given in Table 2.6. In addition, the photomicrograph showing baked biotite crystal in altered matrix is given in Figure 2.23.

Table 2.6 Petrographical analysis results of the specimen (BH-8).

Borehole Number	8
Magnifying	4X
Texture	Seriate
Matrix	Plagioclase microlits+Clay
Major Minerals	Feldspar, Plagioclase
Minor Minerals	Quartz, Biotite, Hornblende
Observations	Existence of alteration and baked biotite crystal in clayey matrix were defined. Pseudomorph plagioclase crystals were seen.

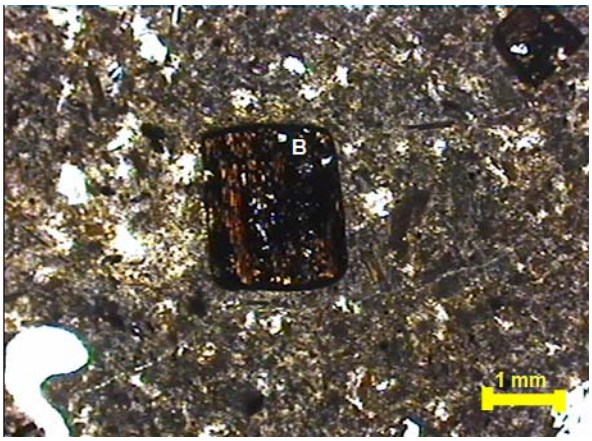

Figure 2.23 The thin section view of the baked biotite (B) crystal is seen in altered matrix under analyser in position.

2.2.1.2. Lithology and Discontinuity Conditions

Considering the factors affecting the behaviour of the rock mass, lithology, anisotropy, heterogenity and discontinuity factors come to the fore. In regard to mechanical behaviour of the rock mass, the discontinuity conditions have far more importance than lithology. The factors stated here were compiled at the field investigations to enlighten the physical characterization of andesites that constitute the hill in which the tunnel construction will take place.

The term lithology includes the type of rock mass, minerological composition, grain size, texture, cementation conditions-degree of cementation and weathering conditions. Lithology can be identified by macroscobic and microscobic investigations. In this thesis, both methods were used to distinguish the lithologies that are located at the study area.

The discontinuity conditions of the andesites and their usage in the rock mass classification systems were mentioned in Chapter 3. For this reason the results of discontinuity observations are not given in details within this chapter.

In regard to survey methods, macroscobic surveys on geological units cropped out at the study area were performed at first. In order to make a correlation between borehole data and surface data, the investigations mostly consantrated on the units exposed near the borehole locations. The result of the observations including the discontinuity surveys are mentioned below.

Starting from the entrance portal's close vicinities the observations were achieved on the upper parts of the hill. The GoogleEarth view of the locations of BH-1, BH-2 and BH-3 is given in Figure 2.24.

Figure 2.24 GoogleEarth screen (2008) showing the locations of BH-1, BH-2 and BH-3.

Since the lower elevation of the hill icluding the tunnel entrance portal is completely covered by unplanned housings, most of the andesite outcrops lay under these artificial structures. Therefore, large scaled investigations on the andesites at this site couldn't be performed.

The flow structure of andesites observed on the upper parts of the hill near B-1 and BH-2 is presented in Figure 2.25. The discontinuity conditons are given in the scan-line survey forms in Appendix A. In general, the discontinuity surfaces are rough and the apertures are mostly filled with clay. Additionally, the surfaces are moderately weathered. In Figure 2.26, another vision of the andesites at the upper parts of the hill, near BH-1 and BH-2 is given.

Figure 2.25 The flow structures of andesites located on the upper parts of the hill near B-1 and BH-2.

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Figure 2.26 The appearance of the andesites exposed at the upper parts of the hill, near BH-1 and BH-2

The pink andesites exposed near BH-3 are jointed and the discontinuity surfaces are moderately weathered. The spacings between the discontinuity surfaces range between 20-80 cm. A general view of the andesites studied at the site is presented in Figure 2.27. The properties of the discontinuities are defined in the scan-line survey chart given in the Appendix A.

Figure 2.27 A view of the andesites exposed near BH-3

At km: 0+840, the macroscobic observations for the andesites were carried out near BH-5. The investigated andesites will host the tunnel's right tube between km: 0+840 – 0+850. The outcrops of the andesites take place on the right side of Hoca Ahmet Yesevi Road. This easy access to the rock mass enables both the macroscobic observations and the discontinuity surveys.

In Figure 2.28 a satallite image of the investigated area derived from GoogleEarth software is given. This image is taken from Digital Globe in 2008. The eye altitude is 1,18 km and the elevation of the study area is approximately 935 m. According to the software, the coordinates are 39°56´48.84"N and 32° 51´52.2".

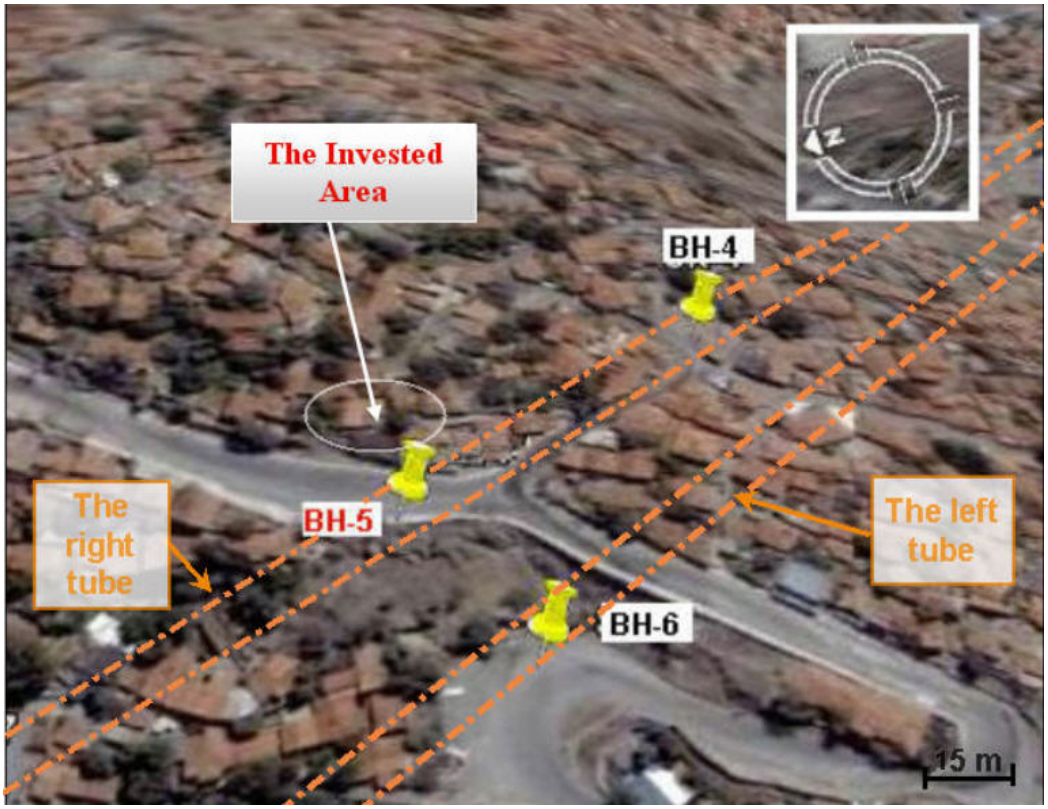

Figure 2.28. The locations of BH- 4, BH-5, and BH-6. The orange dash lines represent the tunnel alignment.

The photographes of the andesites studied at km: 0+840 are given in Figure 2.29.

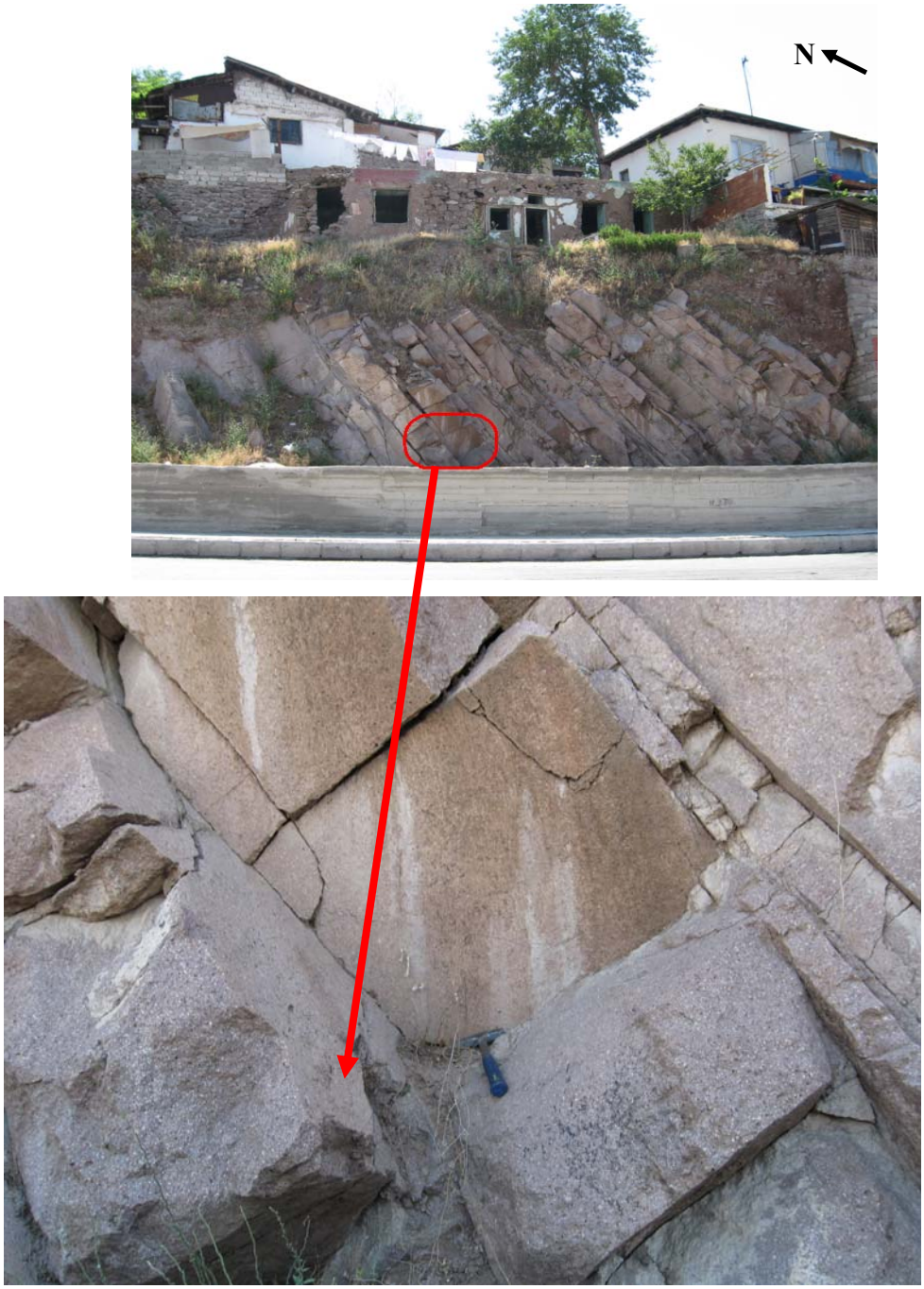

Figure 2.29 The studied andesites near BH-5.

As seen in the photographs (Figure 2.29), the andesites are pink colored and have vesicules covering the surfaces. The constituents composing the cementation material could not be observed since they are not visiable. Big white minerals seen both on the rock faces and in fresh parts are supported by small grain sized minerals that can not be detected by macroscobic surveys. The texture is aphanitic porphyry and the visible big white cystals are sodium riched plagioclases (Figure 2.30).

Figure 2.30 Aphanitic porphyry textured andesites (White crystals seen on the surface are plagioclase crystals).

Depending on the exposed parts, the ansedites are slightly weathered and most parts are fresh. Considering that both the rock mass and the discontinuity surfaces were dry on the different days (March, May and July 2008) of the field investigations and no ground water was detected in the BH-5 (January 2008), this color change among the discontinuity surfaces appears to be the result of leakage from houses that are located on the upper part of the studied andesites. No color change was observed in the fresh parts of the rock mass which implies to the external effect of water.

The field investigation on the andesites held on at the drilling site of BH-6 (Figure 2.31). According to satallite images, the coordinates of the study area are E 32°51´50.04” and N 39°56´48.12”.

Figure 2.31 The photograph of the andesites located at km: 0+880; near BH-6.

The unit examined near BH-6 is the continuation of the andesites previously studied at BH-5. The elevation of the studied andesites is 920 m. Altough the geological unit is the same, the discontinuity oritentations and degree of weathering differ than those of andesites observed at BH-5. Most of the exposed parts of the pink andesites are fructured and moderately weathered. Big and branchy type of joints covers the intact rock masses (Figure 2.32). Clay constitutes the infilling material of these joints.

Figure 2.32. The andesites at km:0+840, near the BH-6.

The main difference of this unit is that the andesites are kaolinized mostly at the upper elevations. In regard to texture, aphanitic texture was observed.

At lower elevations of the hill (860 m) more kaolinized andesites crop out under the artificial structures. These andesites show up in dirty white color. Moreover it is hard to differentiate them from the concrete at some places. In Figure 2.33, photographs of the kaolinized andesites are given.

Figure 2.33. The kaolinized andesites with clay infillings.

Any information about the grain size or texture of the andesites could not be derieved. However, andesites can be generalized as moderately weathered. The discontinuity surfaces are rough and apertures are filled with clay. As for the dirty white color of the outcrops, kaolinization is considered. According to the research of Seyhan (1971), kaolinization was generally determined on the andesites exposed in the inner parts of West Anatolia.

2.3 Hydrogeology of the Tunnel Route

Hıdırlıktepe is formed by andesites that can be considered as impervious because of their low conduit capacities. At the in-stu investigations, andesites are determined as dry. According to the borehole observations carried out by Alkon Engineering Company (2008), the water table wasn't observed at any of eight boreholes. Neverthless, it would not be realistic to define the depths of 25-100 m as dry. It is convenient to except damp condition for those depths of andesites.

There is no significant stream located at the close vicinity of the project site except the arroyo of Bentderesi.

2.4 Structural Geology

Since the andesites are mostly covered with artificial structures, any effect of regional tectonic activity can not be observed. Only the flow structures and joints of andesites outcropped at the site were investigated.

2.4.1 Faults

No faults exist at Hıdırlıktepe and its close vicinities. Therefore, there are not any risks for faults cutting/coinsiding the proposed tunnel route.

2.4.2 Seismicity

According to the General Directorate of Disaster Affairs Earthquake Research Department, the New Ulus Tunnel and the study area take place in the third degree of earthquake zone (Figure 2.34) which indicates a ground accelaration of 0.3-0.2 g.

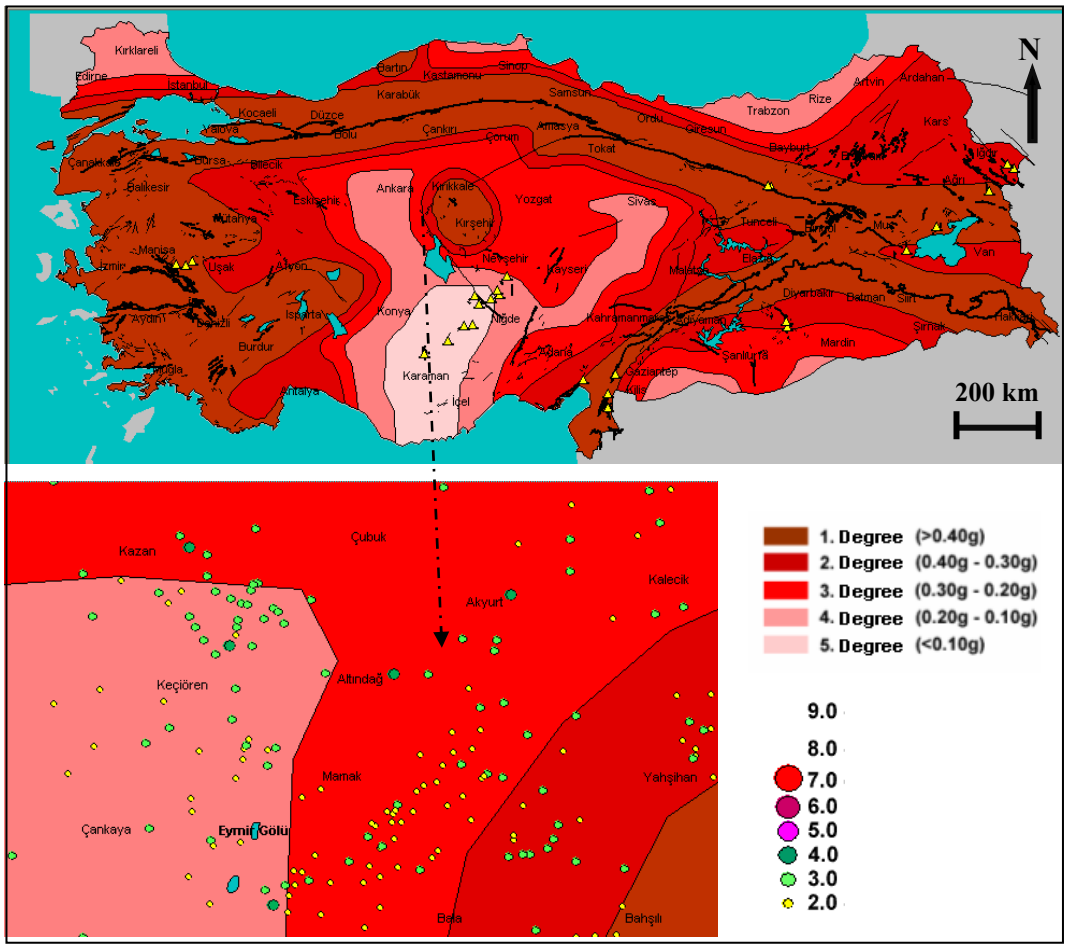

Figure 2.34 Seismic zonation map of Turkey showing the locations of earthquake epicenters which have been determined in the close vicinity of the study area. (www.sayisalgrafik.com/deprem). In this figure, the colored circles indicate the magnitudes of earthquakes that are recorded by Kandilli (2008).

The major earthquake occured in the close vicinity (Altındağ) has an instrumental magnitude of 4.2 and a depth of 33 km, and the date of its occurance is 18.06.1968. In the close visinity another earthquake with a magnitude of 3.7 (Kandilli records) and a depth of 13 km was recorded in 1980.

CHAPTER 3

GEOTECHNICAL CHARACTERIZATION OF THE ANDESITE ROCK MASS

Tunneling projects are envisioned considering the conditions of geologically controlled rock mass. This implies to the impossibility of a design stage in which geomechanical parameters are not consulted. Therefore, detailed researches related to geological situation of the site are performed. In the case of deficient geological data availability, rock mass classification systems are benefitted in both feasibility and preliminary design stages.

In this thesis, the geotechnical characterization of the andesites exposed on the site was determined by using recently developed rock mass classification systems and analytical approaches in which laboratory and in-stu test results are evaluated. The classification systems were also used to define the support systems of The New Ulus Tunnel.

3.1. Geotechnical Investigations

Site characterization tests are divided into two catergories which are field testing and laboratory testing. Site assessment is accomplished when the following informations are achieved (Bieniawski, 1989):

1. Types of rock invested at the study area
2. Overburden depth and character
3. Macroscobic scale discontinuities, such as faults
4. Conditions of groundwater
5. Problematic features such as swelling rock, weak ground or landslides

3.1.1 Field Studies

This stage includes observations of rock outcrops at the study area. At first the physical properties such as color, texture, macroscobic definitions of minerals, degree of weathering and wetness (in the case of water existence) were descibed. Then detailed discontinuity surveys, the most important part of the field investigation, were performed. In addition to surface surveys, eight boreholes were drilled in the context of subsurface investigations.

3.1.1.1 The discontinuity surveys

The conditions of discontinuities are very significant for engineering designs. Orientations, seperations, infillings, roughness and many of describing properties of discontinuites direct the design stages of the engineering applications. Hence ISRM (1981) developed a description system for the discontinuity conditions. The properties of discontinuities observed in andesites are mentioned within the explanations of the discontinuity attributes. In addition, scan-line survey charts depending on the suggestions of ISRM (1981) were prepared to reveal the discontinuity conditions of the andesites. The charts are given in Appendix A.

Since the tunnel portals are crucial, investigations on joint systems were consantrated on these areas. Indeed, among the tunnel alignment most of the andesite outcrops are covered with houses which prevent the measurements. For the places where no measurements are available, the previous studies of Ercanoğlu (1997) were used. Totally 175 discontinuity measurements were taken from the study area.

According to the descriptions of ISRM (1981), the discontinuities observed at the site vicinity are defined as joints. In regard to the spacing, it ranges between 0,05-1,40 m. The site surveys on andesite outcrops indicate that the persistence of the joints has an interval between 2-10 m. Besides, the outcrops that cannot be reached but seen from a distance revealed that the persistance of the discontinuities reaches more than 30 m. Also, a few toppling occurrences releated with the high persistence of the discontinuities were observed near the location of BH-5. The discontinuity surfaces of the andesites were described as rough. The measurements on discontinuities showed that the aperture values range between 0,6 to 20 mm. Especially near the exit portal, the discontinuities exhibit closer apertures contrary to the ones observed near the entrance portal. In respect of the filling material, mostly clay infillings were defined within the joints of the andesites. In addition, sand occurrence and sandy particles were also observed as the infillings. At the upper parts of the andesites, surface staining of the discontinuity surfaces was also ascertained. Altough there are slightly weathered discontinuity surfaces, the prevailing degree of surface weathering is moderate. The previous researches (Kılıç et al., 2000) on Mamak formation andesites also confirm that the dominant weathering degree is moderate.

3.1.1.2 Drillings

In order to determine the geomechanical parameters of the rock mass exposed along the tunnel alignment, a total of 425 m of drilling was performed by 8 boreholes. All boreholes were drilled by Alkon Engineering Corp. (2008). For the drillings two Cralious D-500 Rotary type of drilling machines were used. At the machine NWG (single tube) and NWM (double tube) T-76 core tubes were used. The second machine worked with wire-line and used HQ (63, 5 mm dia) and NQ (47,6 mm dia) core tubes.

Determination of lithological units was accomplished with the help of borehole logs and tests applied on cores taken at drillings. In logging phase total core recovery (TCR), rock quality designation (RQD), fracture frequency and strength data were involved. Conditions of joints and weathering were also assessed by core-box surveys. The borehole logs and the core box photographs are given in Appendix C and D, respectively.

The drillings were aimed to cut the tunnel elevation to reveal the region surrounding the tunnel. The software acquired satallite image showing locations of boreholes is given in Figure 3.1.

Figure 3.1 A satalite image acquired from Google Earth (2008). The red dash line represents the planned road line as the blue line shows the tunnel.

The attributes of boreholes such as location, elevation, depth, altitude and coordinates are indicated in Table 3.1.

Table 3.1. The borehole data

Borehole No	Place/Km	Northing (Latitude)	Easting (Longitude)	Elevation (m)	Depth (m)
BH-1	0+156	39°56´33.09”	32°52´12.09”	870,264	20
BH-2	Tunnel Entrance-Left tube /0+255	39°56´34.97”	32°52´7.93”	868,884	50
BH-3	0+500	39°56´38.58”	32°51´58.28”	866,124	40
BH-4	Left Tube/ 0+772	39°56´45.42”	32°52´7.93”	862,200	100
BH-5	Right Tube/ 0+840	39°56´48.84”	32°51´52.2”	862,214	90
BH-6	Left Tube/ 0+900	39°56´48.12”	32°51´50.04”	861,524	50
BH-7	Tunnel Exit-Right Tube/ 0+970	39°56´52.26”	32°51´47.88”	860,700	35
B.H. 8	Tunnel Exit-Left Tube/ 0+962	39°59´50.82”	32°51´50.82”	860,850	40

Based on the field surveys and drillings a cross-section and a plan view through the tunnel route were prepared. The plan view of the New Ulus Tunnel route and borehole locations appear in Figure 3.2.

At the beginning of the project BH-1 was located on the left tube at the entrance portal. Now it falls behind the left tube of the entrance portal since the tunnel was displaced approximately 35 m ahead. Of all the eight boreholes only BH-1 and BH-3 are located off the tunnel route. Except these two, all boreholes intersect the tunnel line. In Figure 3.3 the cross section of the tunnel line featuring the borehole locations is presented.

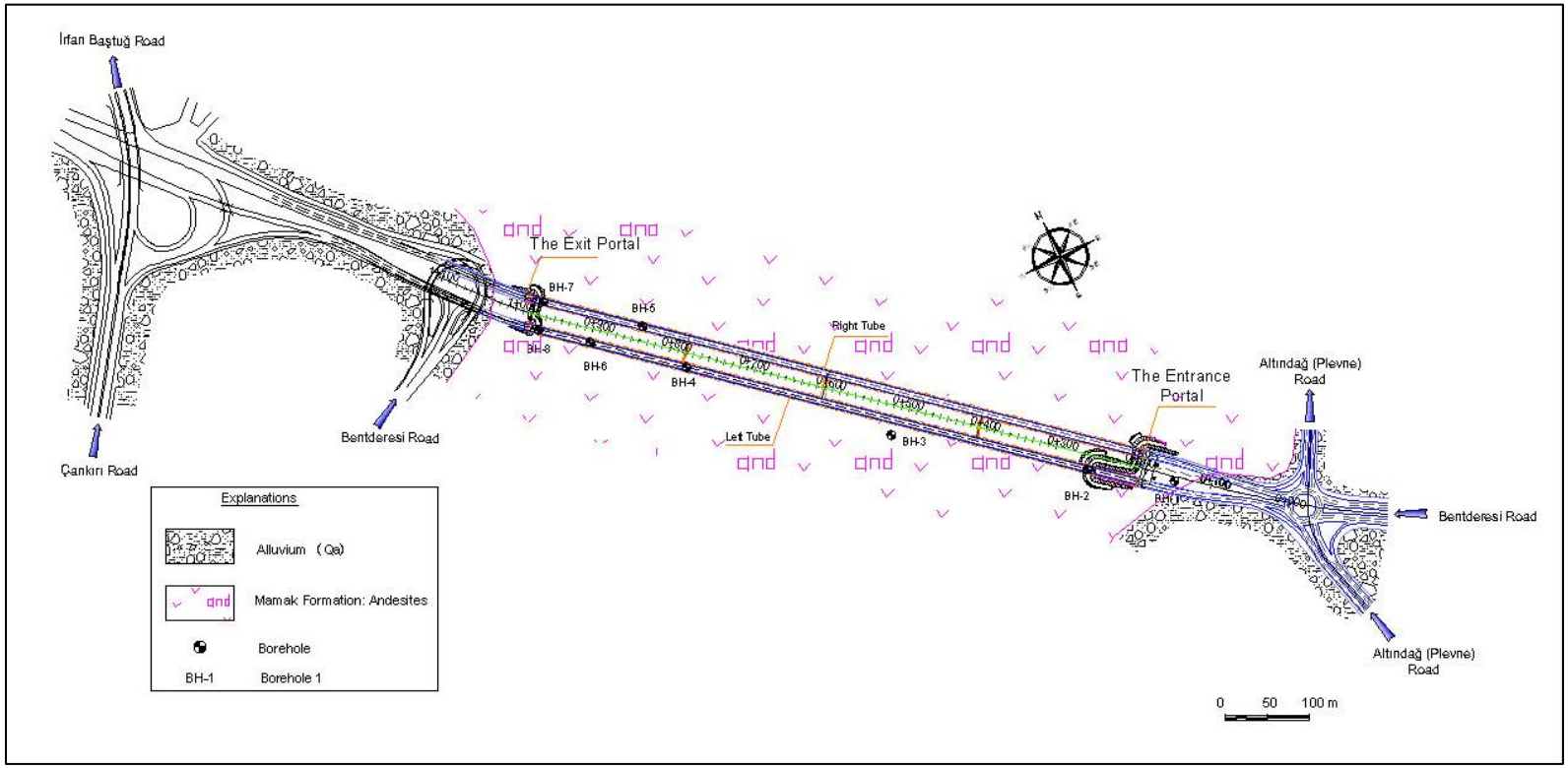

Figure 3.2. The plan view of the tunnel alignment

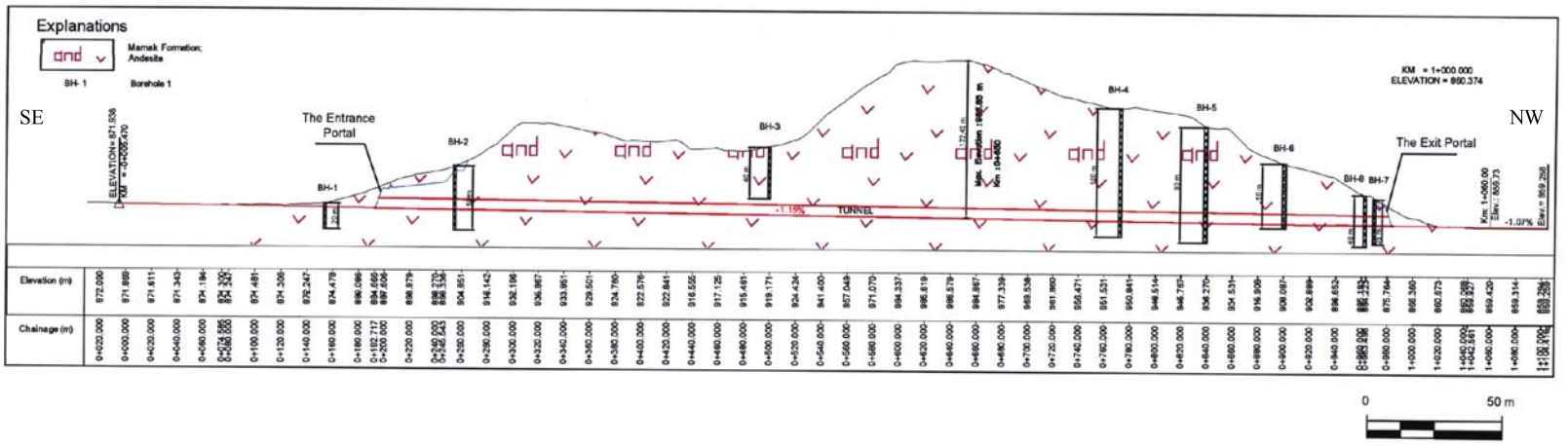

Figure 3.3. The cross-section of the New Ulus Tunnel

3.1.2 Laboratory Tests

The geomechanical parameters of the andesites are fundamental in the designs and support systems of the tunnel. In order to achieve these parameters rock mechanics tests were applied to 39 rock core samples taken from 8 boreholes. In the context of laboratory tests uniaxial compressive strength, point load and unit weight tests were performed by EFOL Geotechnic Services Limited Company (2008). The results of rock mechanic tests are given in Table 3.2.

Table 3.2 The results of uniaxial compressive strength, point load and unit weight tests (after Efol. Geotechnic Services Limited Comp., 2008)

Borehole No	**Depth (m)**	**Dry Unit Weight (γ_s) kN/m^3**	**Point Load Strength Index $Is_{(50)}$ (MPa)**	**Uniaxial Comp. Strenght (σ_c) MPa**
BH-1	15.00-15.20	23,24	-	52,28
BH-2	6.50-6.70	23,34	-	53,5
“	14.50-15.00	22,75	-	44,42
“	18.50-18.75	23,34	-	56,06
“	23.70-24.00	23,24	-	46,11
“	32.00-32.30	23,04	-	29,60
BH-3	8.60-9.00	23,04	-	43,06
“	9.00-19.00	-	1.82	40,04*
“	15.50-16.00	-	3.17	69,74*
“	18.00-18.30	22,75	-	45,94
“	25.10-25.30	22,85	-	35,19
BH-4	48.50-50.00	23,43	-	53,92
“	56.30-56.50	23,04	-	18,05
“	63.00-63.20	-	1.03	22,66*
“	67.00-69.00	-	2.26	49,72*
“	74.30-74.50	23,24	-	48,34
“	80.60-80.90	23,24	-	23,92
BH-5	47.50-48.00	22,94	-	26,70
“	51.80-52.00	22,55	-	33,45
“	60.30-60.70	22,75	-	21,80
“	70.50-71.00	22,85	-	45,54
“	71.00-79.00	-	0.61	13,42*
“	79.00-79.20	21,47	-	6,46
BH-6	14.50-14.48	22,85	-	38,98

“	22.00-22.50	23,14	-	47,11
“	26.00-26.20	23,04	-	39,91
“	32.40-32.60	23,04	-	21,36
“	37.20-37.50	-	0.17	3,74*
BH-7	9.00-9.40	22,65	-	51,34
“	9.50-20.00	-	2.08	45,76*
“	11.80-12.00	22,85	-	44,30
“	15.80-16.00	23,14	-	45,03
“	22.50-22.70	22,16	-	32,88
BH-8	8.50-8.70	22,45	-	40,92
“	12.00-12.26	22,16	-	40,48
“	13.00-17.00	-	1.25	27,5*
“	15.50-15.80	22,65	-	27,22
“	22.00-29.00	-	0.15	3,3*
“	27.50-28.00	23,04	-	41,57

* According to the previous studies (ISRM,1985; Bieniawski 1975; Cavagnaro 1980) that are mentioned by Topal (2000) the uniaxial compressive strength of igneous rocks is equal to 22-24 times the point load strength index. In this thesis the coefficient is selected as 22 in order to convert the Is_{50} values to σ_c values.(σ_c=22x Point load strength index)

3.2. Application of the Classification Systems to the Andesites

In this section application of the classification systems (RMR and Q) on the geological units ascertained at the study area is under scope. In the context of classification systems, the geomechanical parameters of rock mass are assessed with the help of ratings which are built up depending on the conditions of discontinuities. Since there is a quite difference between discontinuity properties, the maximum and minimum conditions were assessed separately in the classifications. For this reason, the classification results exhibit as intervals.

According to the site investigations, four main joints sets and random joints were determined. The orientations of joint sets are given in Table 3.3

Table 3.3. Orientations of major joint sets observed at the study area

Set No	Dip	Dip Directions
Set 1	67	203
Set 2	77	350
Set 3	37	043
Set 4	66	096

Using the software Dips 5.1, the dip and dip directions of the joints were plotted. The direction of the tunnel drive is SE –NW which is represented by the arrows in the following plot (Figure 3.4).

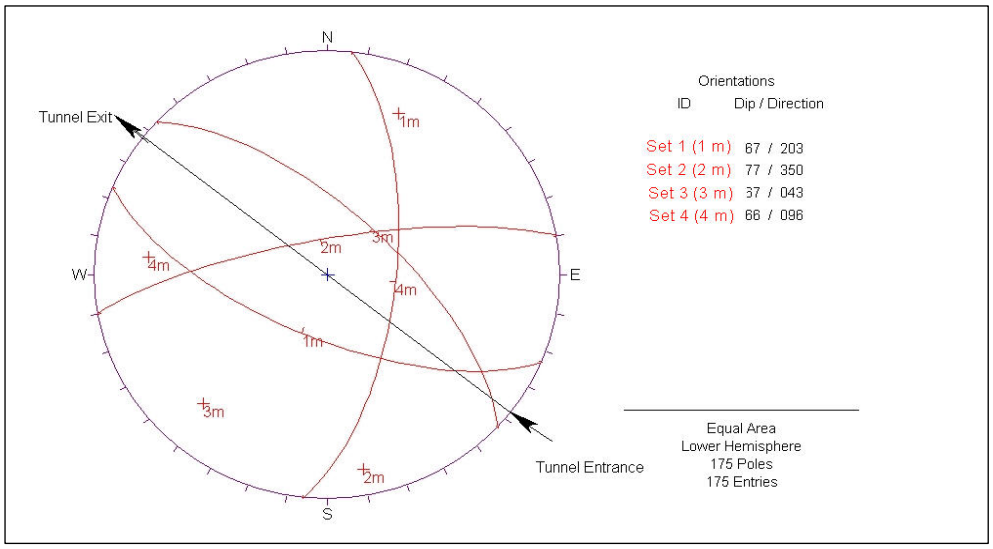

Figure 3.4. The illustration of major discontinuity set orientations

3.2.1 Application of the RMR System

In accordance with the site observations, the borehole data were used to classify the andesites hosting the New Ulus Tunnel. In the RMR classifications (Bieniawski, 1989), borehole depths coinciding the tunnel elevations were taken into consideration to obtain reliable data for the selection of support systems. Since BH-1 and BH-3 do not intersect the tunnel line, the data obtained from these boreholes were benefitted in only classification of the rock mass. The classified andesites were divided into groups which were represented by the chainage of the planned route.

Km: 0+100-0+200 m (in accordance with BH-1)

In order to assess the RMR rating, RQD values obtained from BH-1 were used. The rest of the classification parameters depend on the site investigations of the exposed andesites located between Km:0+100-0+200 m. RMR application results are given in Table 3.4. the orientations of discontinuity sets are given in Table 3.5.

Table 3.4. RMR application to andesites located between 0+100-0+200 m

0+100- 0+200 m (BH-1)		
Parameters	**Value**	**RMR Rating**
RQD (%) Between 0.00-20.00 m	0-27	3-6
Uniaxial Compressive Strength (σ_c)	52,3 MPa	6
Condition of Discontinuities		
Spacing	100-400 mm	7-10
Persistance	10-4 m	2
Aperture	15-7 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	Moderately weathered	3
Ground water	Damp	10
Basic RMR Rating		36-42
Rating adjustment	Very unfavourable	-12
Total RMR Rating		**24-30**
Description		**Poor Rock**

Rating adjustment for discontinuity orientations

Table. 3.5. Orientations of major joint sets at km:0+100-0+200

Discontinuity Set	Dip	Dip Direction
Set 1	73	207
Set 3	68	047

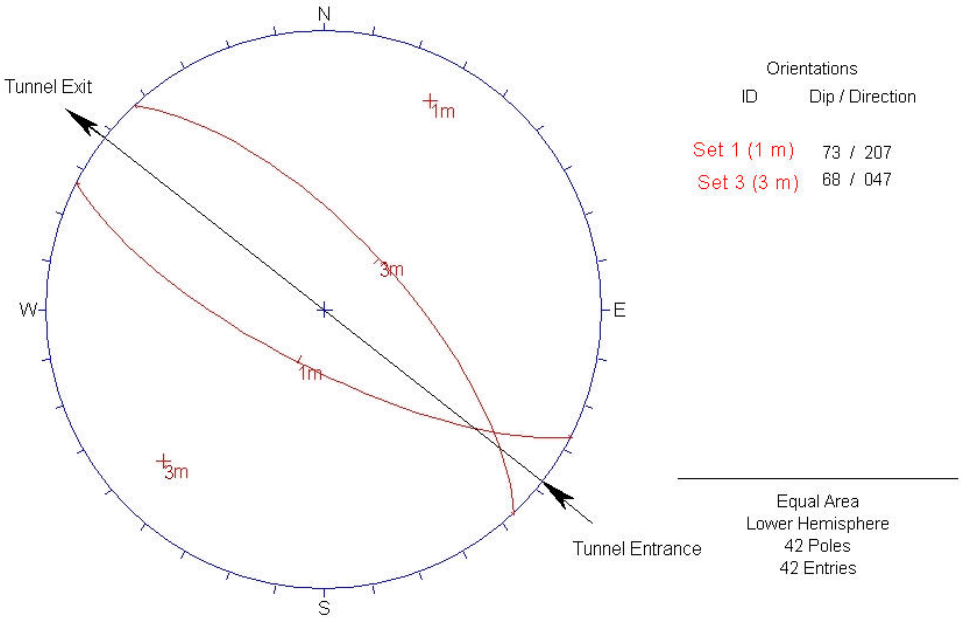

Figure 3.5. The orientations of major discontinuity sets at km:0+100-0+200

Altough there are two discontinuity sets (73/207, 68/47) the most critical set is considered in the rating adjustments. Since Set 1 (73°/207°) strikes parallel to the tunnel axis, it is defined as the critical set. According to RMR rating table (Bieinawski, 1989) the orientation of discontinuity set is very unfavourable which corresponds to -12 rating.

Km: 0+200-0+300 (in accordance with BH-2)

In order to assess the RMR rating, RQD values obtained from BH-2 were used. The rest of the classification parameters depend on the site investigations of the exposed andesites. RMR application results are given in Table 3.6. The discontinuity orienatations are given in Table 3.7 and illustrated in Figure 3.6.

Table 3.6 RMR application to the andesites located between km:0+200-0+300

Km: 0+200- 0+300 m (The Entrance Portal/ BH-2)		
Parameters	**Value**	**RMR Rating**
RQD (%) Between 25,00-36,00 m	10-41	4-8
Uniaxial Compressive Strength (σ_c)	29,60- 46,11 MPa	4-6
Condition of Discontinuities		
Spacing	180-550 mm	7-11
Persistance	10-3 m	2
Aperture	15-5 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	Moderately weathered	3
Ground water	Damp	10
Basic RMR Rating		35-45
Rating adjustment	Very unfavourable	-12
Total RMR Rating		**23-33**
Description		**Poor Rock**

Rating adjustment for discontinuity orientations

Table 3.7 The discontinuity orientations at km:0+200-0+300

Discontinuity Set	Dip	Dip Direction
Set 1	73	207
Set 3	79	039

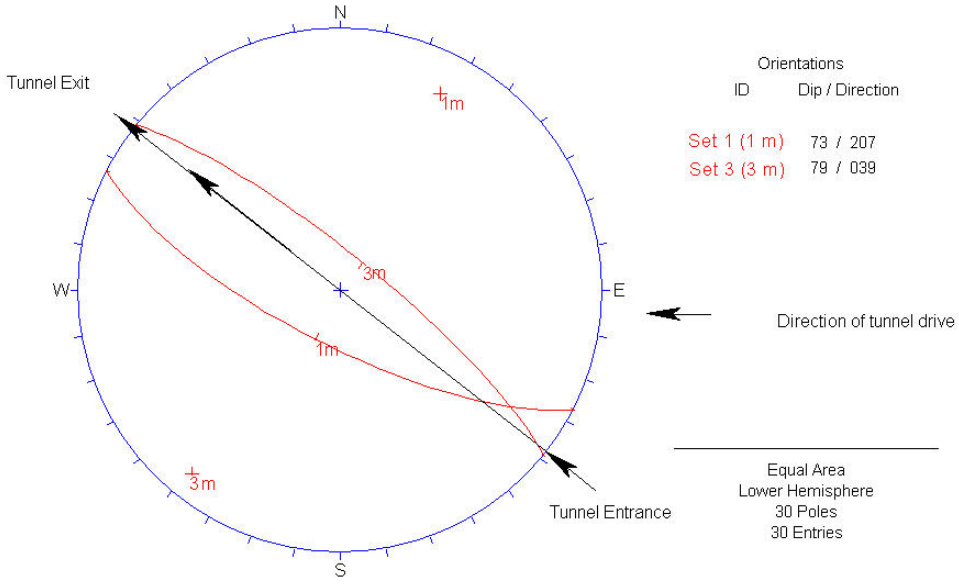

Figure 3.6. Orientation of major discontinuity sets at km:0+200-0+300

The discontinuity sets (73°/207° and 79°/039°) strike parallel to the tunnel axis and dip at greater degrees than 45°. According to the RMR rating table (Bieniawski, 1989), the discontinuity orientations are very unfavourable. For this reason the adjustment rating was taken as -12.

Km: 0+300-0+400 (in accordance with BH- 3)

According to the data derieved from BH-3, the following rating table (Table 3.8) was prepared.

Table 3.8 RMR application to the andesites located between 0+300-0+400 m

Km: 0+300- 0+400 m (BH-3)		
Parameters	**Value**	**RMR Rating**
RQD (%) Between 5,00-24,00 m	0-68	3-14
Uniaxial Compressive Strength (σ_c)	40,04- 69,74 MPa	5-7
Condition of Discontinuities		
Spacing	180-600 mm	8-12
Persistance	10-5 m	2
Aperture	30-8 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	Slightly weathered	5
Ground water	Damp	10
Basic RMR Rating		38-55
Rating adjustment	Very unfavourable	-12
Total RMR Rating		**26-43**
Descriptions		**Poor-Fair Rock**

Rating adjustment for discontinuity orientations

The discontinuity orienatations are given in Table 3.9 and illustrated in Figure 3.7.

Table 3.9. The discontinuity orientations at km:0+300-0+400

Discontinuity Set	Dip	Dip Direction
Set 1	74	197
Set 3	79	039

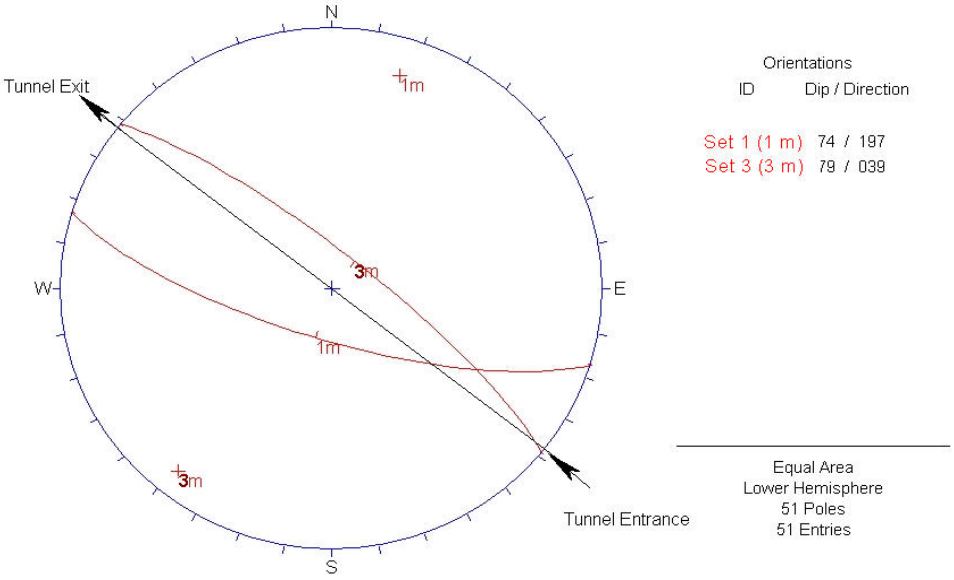

Figure 3.7. Dip and dip directions of discontinuity sets observed at km:0+300-0+400

The rose and dip/dip direction plots of the discontinuity sets revealed that there is a critical discontinuity set (79°/222°) which strikes parallel to the tunnel axis and dip at 79°. This situation denotes very unfavourable tunneling condition with a rating of -12 for the rating adjustments.

Km:0+780-0+840 (in accordance with BH- 4)

Since there are not any andesite outcrops near BH-4, the closest andesite exposures at km:0+840 were used to obtain the discontinuity conditions. Nevertheless, the borehole data of BH-4 was benefitted in the RMR applications given below. The orientations of the discontinuities are given in Table 3.10. The plots of discontinuity sets are given in Table 3.11. The illustration of major discontinuity sets is given in Figure 3.8.

Table 3.10. RMR application to the andesites located between 0+780-0+840 m

Km: 0+780- 0+840 m (BH-4)		
Parameters	**Value**	**RMR Rating**
RQD (%) Between 68,00-87,00 m	0-55	3-11
Uniaxial Compressive Strength (σ_c)	23,92 -49,72 MPa	3-6
Condition of Discontinuities		
Spacing	45-1400 mm	5-17
Persistance	14-2 m	1-4
Aperture	15-1 mm	0-4
Roughness	Rough	5
Infilling	Soft filling>5 - <5 mm	0-2
Weathering	Moderately weathered	3
Ground water	Damp	10
Basic RMR Rating		30-62
Rating adjustment	Very unfavourable	-12
Total RMR Rating		**18-50**
Description		**Very Poor-Fair Rock**

Rating adjustment for discontinuity orientations

Table 3.11. The orientations of discontinuities at km:0+780-0+840

Discontinuity Set	Dip	Dip Direction
Set 1	59	212
Set 4	75	093
Random	76	150

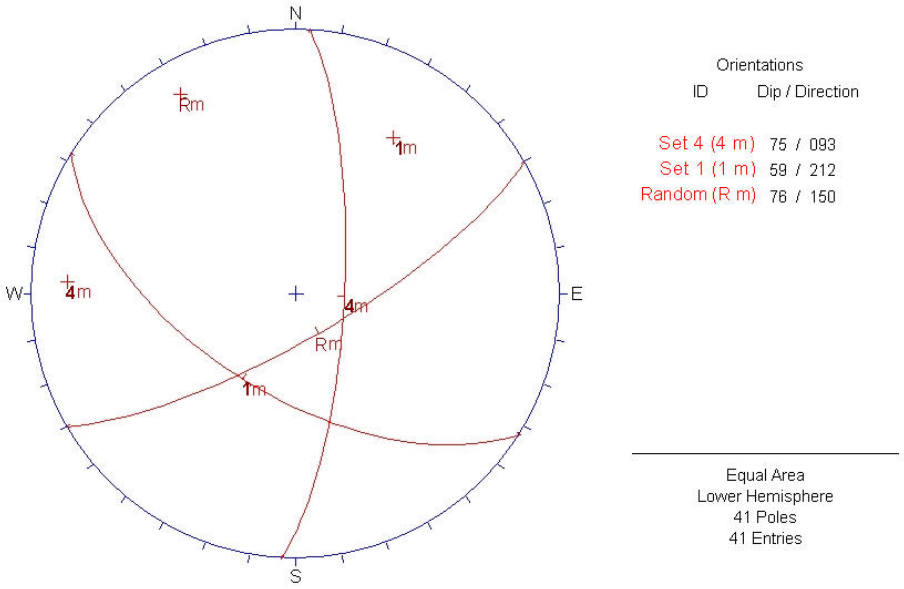

Figure 3.8. The illustration of major discontinuity sets near to BH-4.

The tunnel will be driven parallel to the strike of the discontinuity set 1(59°/212°). Considering both strike and dip of the discontinuity set, the orientations are defined as very unfavourable in the context of RMR rating adjustment (Bieniawski, 1989).

Km:0+800-0+850 (in accordance with BH-5)

In addition to the site investigations, the data obtained from BH-5 was used in the classifications.The results are given in Table 3.12.

Table 3.12 RMR application to the andesites located between 0+800-0+850 m

Km: 0+800- 0+850 m (BH-5)		
Parameters	**Value**	**RMR Rating**
RQD Max.(%) Between 61,00-80,00 m	0-69	3-14
Uniaxial Compressive Strength (σ_c)	6,46-45,54 MPa	5-1
Condition of Discontinuities		
Spacing	45-1400 mm	5-17
Persistance	14-2 m	1-4
Aperture	40-1 mm	0-4
Roughness	Rough	5
Infilling	Soft filling>5mm , < 5	0-2
Weathering	Slightly weathered	5
Ground water	Damp	10
Basic RMR Rating		34-62
Rating adjustment	Very unfavourable	-12
Total RMR Rating		**22-50**
Descriptions		**Poor-Fair Rock**

Rating adjustment for discontinuity orientations

The discontinuity orientations (Table 3.13) and illustrations (Figure 3.9) are given below.

Table 3.13.The orientations of discontinuities at km:0+800-0+850

Discontinuity Set	Dip	Dip Direction
Set 1	59	212
Set 4	75	093
Random	76	150

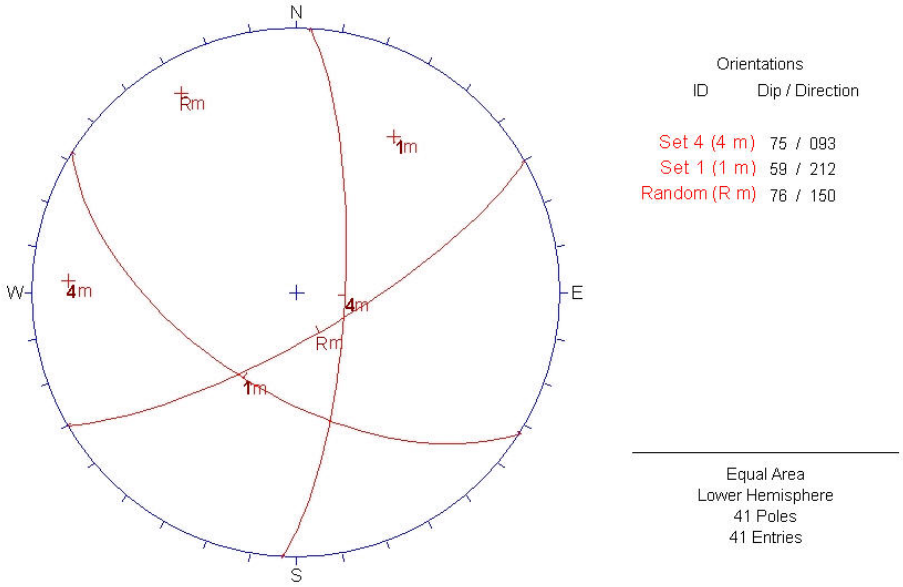

Figure 3.9. Illustration of major discontinuity sets at km:0+800-0+850

The Set 1 (59°/212°) constitute the most critical discontinuity which strikes nearly parallel to the tunnel axis. Under that circumstances the tunneling condition appears to be very unfavourable with a rank of -12 for tunnel rating adjustment.

Km:0+840-0+950 (in accordance with BH- 6)

For the classifications, the RQD values obtained from BH-6 was used. The results aretabulated in Table 3.14. The discontinuity orientations (Table 3.15) and major discontinuity set plot (Figure 3.10) is given below.

Table 3.14. RMR application to the andesites located between 0+840-0+950 m

Km: 0+840- 0+950 m (BH-6)		
Parameters	**Value**	**RMR Rating**
RQD (%) Between 31,00-50,00 m	0-72	3-14
Uniaxial Compressive Strength (σ_c)	3,74-21,36 MPa	1-3
Condition of Discontinuities		
Spacing	150-600 mm	7-12
Persistance	7-12 m	2-1
Aperture	15-6 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	Moderately weathered	3
Ground water	Damp	10
Basic RMR Rating		31-48
Rating adjustment	Very unfavourable	-12
Total RMR Rating		**19-36**
Descriptions		**Very Poor – Poor Rock**

Rating adjustment for discontinuity orientations

.

Table 3.15 The orientations of discontinuity sets at km:0+840-0+950

Discontinuity Set	Dip	Dip Direction
Set 1	68	205
Set3	66	036
Set 4	75	093

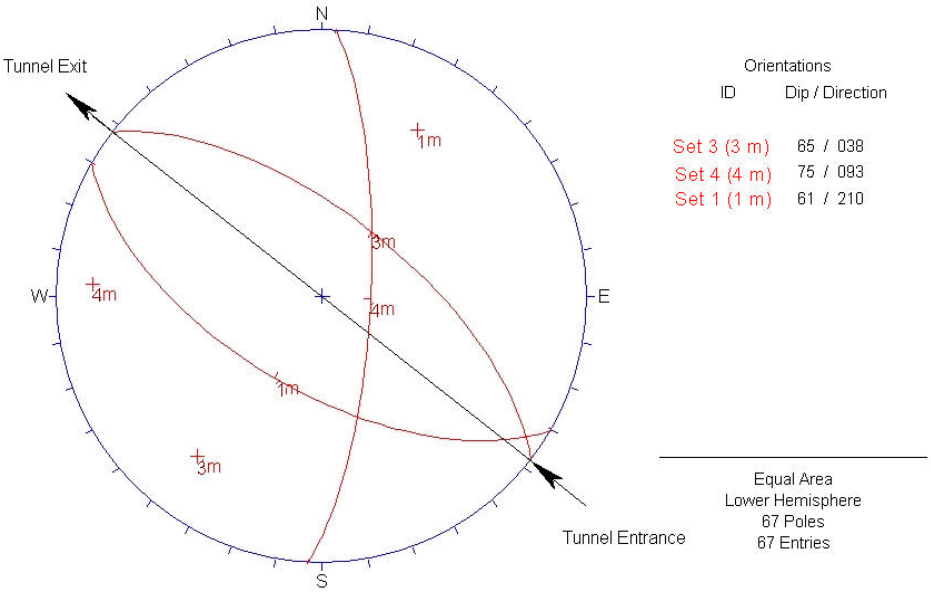

Figure 3.10. The plot ot major discontinuity sets at km:0+900

The critical discontinuity set observed at the locations between 0+840-0+950 m strikes parallel to the tunnel axis. Under that circumstances unstable tunneling conditions are expected. For this reason the adjustment factor was taken as -12.

Km:0+950-1+000 (in accordance with Borehole 7)

Since there are not any andesite outcrops at the close vicinities of tunnel exit portal, the related previous studies of Ulusay, 1975; Kasapoğlu, 1980 and Ercanoğlu, 1997 were used . In addition, core taken from BH-7 were also used. The cores demonstrates smilar joint orientations with the cores taken from BH-6. This can be explained by high joint persistancy of andesites. Under that circumstances, joints of andesites that will be faced at the exit portal are excepted as a continuum of the ones that are observed near BH-6. For this reason the results of site investigations near BH-6 were used (Table 3.16).

Table 3.16 RMR application to the andesites located at 0+950-1+000 m

Km: 0+950-1+000 m (BH- 7)		
Parameters	**Value**	**RMR Rating**
RQD (%) Between 2,00-21,00 m	0-63	3-12
Uniaxial Compressive Strength (σ_c)	44,30-51,34 MPa	5-6
Condition of Discontinuities		
Spacing	100-980 mm	7-14
Persistance	6-2 m	2-4
Aperture	15-5 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	Moderately weathered	3
Ground water	Damp	10
Basic RMR Rating		35-54
Rating adjustment	Very unfavourable	-12
Total RMR Rating		**23-42**
Descriptions		**Poor-Fair Rock**

Rating adjustment for discontinuity orientations

Depending on the situations mentioned above, the following discontinuity sets (Table 3.17) were considered for the rating adjsutments. The illustrations of discontinuity sets are given in Figure 3.11.

Table 3.17.The orientations of major discontinuity sets at km:0+950-1+000

Discontinuity Set	Dip	Dip Direction
Set 1	68	205
Set 3	66	036

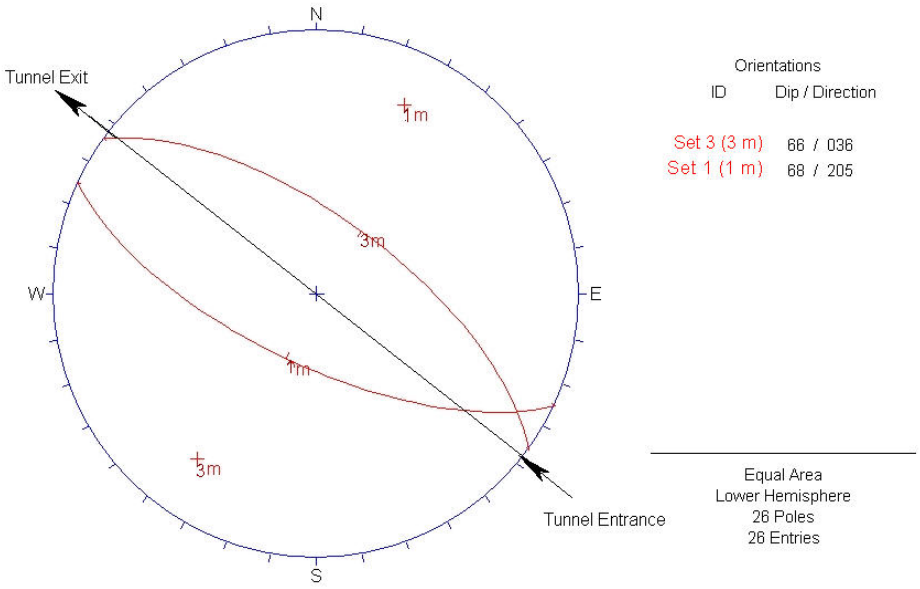

Figure 3.11. The plot representing the major discontinuity set orientations

According to the rose diagram, the critical joint sets 1 (66/205) and Set 3(66/036) strike parallel to the tunnel axis. And the dips of the sets fall within the interval representing very unfavourable conditions. As a consequent, the rating adjustment is – 12.

Km:0+950-1+000 (in accordance with Borehole 8)

Since BH 8 was located on the opposite of BH 7 (within a close distance), the discontinuity properties were excepted as more or less the same. For this reason the same discontinuity conditions were consided in the RMR applications (Table 3.18).

Table 3.18 RMR application to andesites located at km: 0+950-1+000

Km: 0+950 -1+000 m (BH-8)		
Parameters	**Value**	**RMR Rating**
RQD (%) Between 2,51-22,51 m	0-67	3-14
Uniaxial Compressive Strength (σ_c)	27,5-40,92 MPa	3-5
Condition of Discontinuities		
Spacing	100-980 mm	7-14
Persistance	6-2 m	2-4
Aperture	15-5 mm	0
Roughness	Rough	5
Infilling	Soft filling > 5 mm	0
Weathering	ModeratelyWeathered	3
Ground water	Damp	10
Basic RMR Rating		35-55
Rating adjustment	Very unfavourable	-12
Total RMR Rating		**21-43**
Descriptions		**Poor-Fair Rock**

Rating adjustment for discontinuity orientations

In Table 3.19. The orienatations of major discontinuity sets are given . In addition, the illustration of these sets are represented in Figıre 3.12.

Table 3.19.The discontinuity sets and their orienatations at km: 0+950 -1+000

Discontinuity Set	Dip	Dip Direction
Set 1	68	205
Set 3	66	036

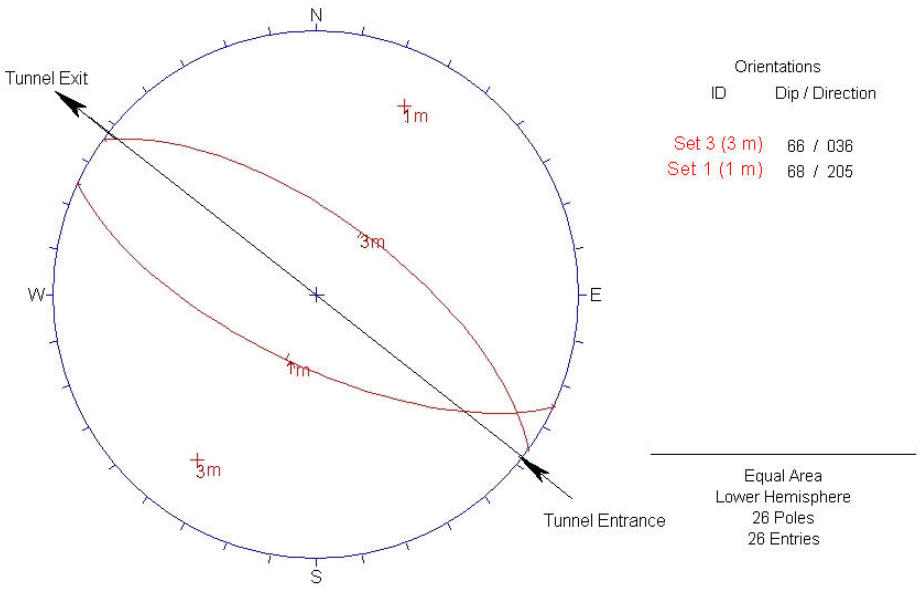

Figure 3.12. The illustration of major discontinuity sets at km:0+950-1+000

As shown in the figure, the discontinuity sets strike parallel to the tunnel axis and dip between 45-90 degrees which generates very unfavourable conditions for tunneling.

The results of RMR classification system in correlation with boreholes are presented in Table 3.20.

Table 3.20. Rock descriptions according to the RMR classification system

Investigation Area/ Borehole Number	Total RMR Rating	Description of the Rock Mass
Km:0+00-0+100/ BH-1	24-30	Poor Rock
Km:0+100-0+200/ BH-2	23-33	Poor Rock
Km:0+300-0+400/BH-3	26-43	Poor - Fair Rock
Km:0+780-0+840 /BH-4	18-50	Very Poor - Fair Rock
Km:0+800-0+850/ BH-5	22-50	Poor - Fair Rock
Km:0+840-0+950/ BH-6	19-36	Very Poor - Poor Rock
Km:0+950-1+000/ BH-7	23-47	Poor - Fair Rock
Kn:0+950-1+000/ BH-8	21-43	Poor - Fair Rock

3.2.2 Q-System (NGI) Applications

In order to classify the individual parameters, the Q system rating tables proposed by Barton et al.(1974) were used. The descriptions of the capital letters used in the following table are also given in Appendix B. In the selection of SRF parameters, the rose diagrams and dip/dip direction diagrams of discontinuities which are shown under RMR applications were benefitted.

The classification results in correlation with each borehole are given in Table 3.21, Table 3.22, Table 3.23. Table 3.24, Table 3.25, Table 3.26, Table 3.27, Table 3.28 and Table 3.29.

Table 3.21 Q system classification for the andesites located at km:0+100-0+200 (in correlation with BH-1)

	Q-System Parameters	Description	Value
BH 1	RQD (%)	Very Poor-Poor	10*-27
	Joint Set Number **(Jn)**	2 sets + random	18**
	Joint Rougness Number **(Jr)**	E	1,5
	Joint Alteration number **(Ja)**	C	2
	Joint Water Reduction **(Jw)**	A	1
	Stress Reduction Factor **(SRF)**	B	5
Rating		**0,08-0,225**	
Description		**Extremely Poor-Very Poor Rock**	
RMR (according to interrelations) 21,63-30,575			

*:Appendix C, Section 1, note 1
**Appendix C, Section 2, note 1

Table. 3.22. Q System classification for the andesites located at km: 0+200-0+300 (in correlation with BH-2)

Entrance Portal	**Q-System Parameters**	**Description**	**Value**
BH 2	RQD (%)	Very Poor-Poor	10-41
	Joint Set Number **(Jn)**	2 sets	8***
	Joint Rougness Number **(Jr)**	E	1,5
	Joint Alteration number **(Ja)**	F	4
	Joint Water Reduction **(Jw)**	A	1
	Stress Reduction Factor **(SRF)**	B	5
Rating		**0,09-0,38**	
Description		**Extremely Poor-Very Poor Rock**	
RMR (according to interrelations) 22,69-35,39			

***Appendix C, Section 2, note 2

Table 3.23. Q system Classification for the andesites located at km: 0+300-0+400 (in correlation with BH-3)

	Q-System Parameters	Description	Value
BH 3	RQD (%)	Very poor- Fair	10*-68
	Joint Set Number **(Jn**)	2 sets	12**
	Joint Rougness Number **(Jr)**	E	1,5
	Joint Alteration number **(Ja)**	C	2
	Joint Water Reduction **(Jw)**	A	1
	Stress Reduction Factor **(SRF)**	B	5
Rating		0,125-0,85	
Description		**Very Poor Rock**	
RMR (according to interrelations) 25,28-42,53			

*Appendix C, Section 1, note 1
**Appendix C, Section 2, note 1

Table 3.24. Q system Classification for the andesites located at 0+780-0+840 (in correlation with BH-4)

	Q-System Parameters	Description	Value
BH 4	RQD (%)	Very Poor -Fair	10*-55
	Joint Set Number **(Jn**)	2 sets + random	18**
	Joint Rougness Number **(Jr)**	E	1,5
	Joint Alteration number **(Ja)**	C	2
	Joint Water Reduction **(Jw)**	A	1
	Stress Reduction Factor **(SRF)**	C	2,5
Rating		0,16-0,916	
Description		**Very Poor Rock**	
RMR (according to interrelations) 27,87- 43,21			

*Appendix C, Section 1, note 1
**Appendix C, Section 2, note 1

Table 3.25. Q system classification for the andesites located at km: 0+800-0+850 (in correlation with BH-5)

	Q-System Parameters	Description	Value
BH-5	RQD (%)	Very Poor -Fair	10*-69
	Joint Set Number **(Jn**)	2 sets + random	18**
	Joint Rougness Number **(Jr)**	E	1,5
	Joint Alteration number **(Ja)**	C	2
	Joint Water Reduction **(Jw)**	A	1
	Stress Reduction Factor **(SRF)**	C	2,5
Rating		0,16-1,15	
Description		**Very Poor-Poor Rock**	
RMR (according to interrelations) 27,87- 45,25			

*Appendix C, Section 1, note 1
**Appendix C, Section 2, note 1

Table 3.26. Q system classification for the andesites located at km:0+840-0+950 (in correlation with BH-6)

	Q-System Parameters	Description	Value
BH-6	RQD (%)	Very Poor -Fair	10*-72
	Joint Set Number **(Jn**)	3 sets	27**
	Joint Rougness Number **(Jr)**	E	1,5
	Joint Alteration number **(Ja)**	C	2
	Joint Water Reduction **(Jw)**	A	1
	Stress Reduction Factor **(SRF)**	B	5
Rating		0,05-0,4	
Description		**Extremely Poor-Very Poor Rock**	
RMR (according to interrelations) 17,98-35,75			

**Appendix C, Section 2, note 1

Table 3.27. Q system classification for the andesites located at km:0+950-1+000 (in correlation with BH-7)

Exit Portal	Q-System Parameters	Description	Value
BH-7	RQD (%)	Very Poor -Fair	10*-63
	Joint Set Number **(Jn)**	2 sets	8**
	Joint Rougness Number **(Jr)**	E	1,5
	Joint Alteration number **(Ja)**	C	2
	Joint Water Reduction **(Jw)**	A	1
	Stress Reduction Factor **(SRF)**	B	5
Rating		0,18-1,18	
Description		**Very Poor-Poor Rock**	
RMR (according to interrelations) 28,93-45,5			

*:Appendix C, Section 1, note 1
**:Appendix C, Section 2, note 2

Table 3.28 Q system classification for for the andesites located at 0+950-1+000 (in correlation with BH-7)

Exit Portal	Q-System Parameters	Description	Value
BH-8	RQD (%)	Very Poor -Fair	10*-67
	Joint Set Number **(Jn)**	2 sets	8**
	Joint Rougness Number **(Jr)**	E	1,5
	Joint Alteration number **(Ja)**	C	2
	Joint Water Reduction **(Jw)**	A	1
	Stress Reduction Factor **(SRF)**	B	5
Rating		0,187-1,256	
Description		**Very Poor-Poor Rock**	
RMR (according to interrelations) 29-46			

*:Appendix C, Section 1, note 1
**:Appendix C, Section 2, note 2

Andesites are characterized as very poor rocks according to the Rock Mass Qualification System. The Q index values and corresponding rock descriptions are summarized in Table 3.29.

Table 3.29. Descriptions of the andesites in accordance with Q system

Borehole Number	Q-System Rating	Description
BH-1	0,08-0,225	Extremely poor- Very poor rock
BH-2	0,09-0,38	Extremely poor- Very poor rock
BH-3	0,125-0,85	Very poor rock
BH-4	0,16-0,916	Very poor rock
BH-5	0,16-1,15	Very poor-poor rock
BH-6	0,05-0,4	Extremely poor- Very poor rock
BH-7	0,187-1,18	Very poor- poor rock
BH-8	0,187-1,256	Very poor-poor rock

The RMR values, obtained from the inter-relation with Q indexes generally corroborate the RMR classifications results. The correlation of the RMR and Q system results are represented in Figure 3.13.

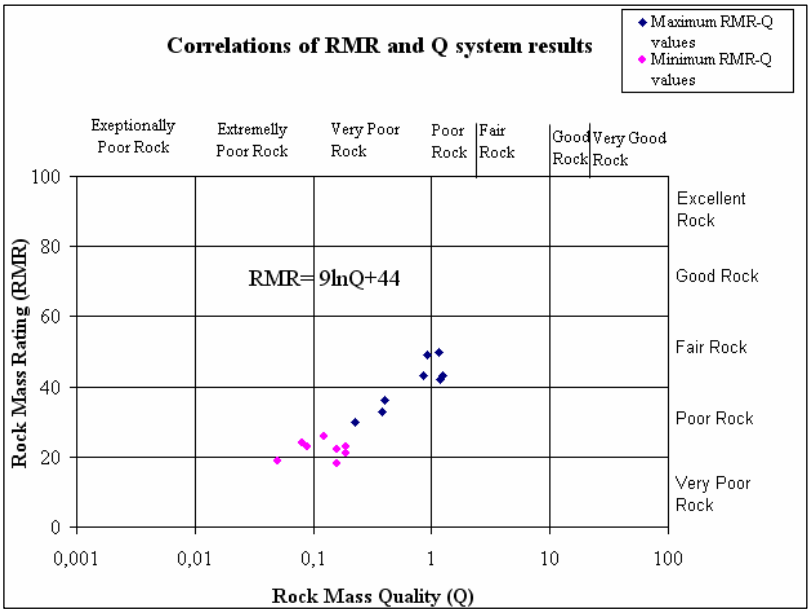

Figure 3.13 The correlation of classification results of RMR and Q systems

As seen in Figure 3.14, the excessive difference between maximum and minimum RQD and uniaxial compressive strength values results in the variability of rock mass classes. According to the figure above (Figure 3.13), the andesites exhibit a wide range of rock quality which indicates a differantiation. This differantiation is assumed to occur depending on hydrathermal alteration.

CHAPTER 4

ASSESSMENT OF THE SLOPE STABILITY AT THE PORTALS BY KINEMATICAL METHOD

Altough gravitation is the major effect triggering the rock mass to move, other geological factors such as discontinuity conditions should not be underestimated. Especially for the structurally controlled slopes, the joint sets and their attitudes define the probability of failures. In addition to the naturely triggered ones, the slope failures are also faced in engineering applications. At the excavation stages the disturbance of rock mass may result in slope failures. The design and the construction stages of the engineering structure are developed depending on these failure conditions. Once the failure surface and the failure type are detected, reliable support design and construction system are formed as done in tunnel apllications.

This chapter covers the slope stability analyses for the entrance and exit portals of the New Ulus Tunnel.

4.1 Kinematic Analyses

The kinematic analyses were performed by using the software Dips 5.1. In order to obtain the required data, scan-line surveys depending on the procedures of ISRM (1981) were conducted. Following the evaluation of survey findings, rose and contour diagrams of the joints were plotted to feature the main situation of the joint systems. The Equal Area Schmidt Projection with Lower Hemisphere selection was choosen for the plots. As for the tunnel strike, 308° was used in the analyses. Depending on the previous studies of Gökçeoğlu et al., (2000) the internal friction angle of the discontinuity surfaces was selected as 30° (Figure 4.1).

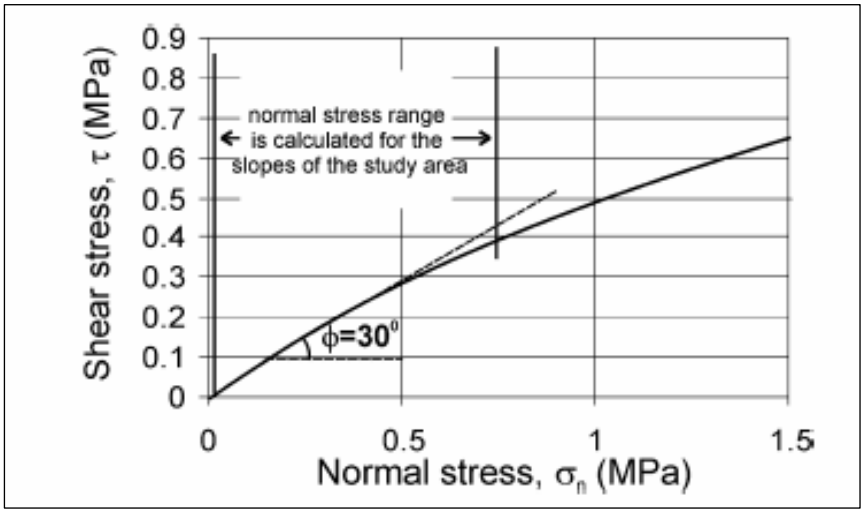

Figure 4.1. Failure envelope based on Barton failure criterion (C. Gökçeoğlu et al., 2000)

4.1.1. Kinematic Analyses Applications

According to the scan-line survey results, random discontinuities and four major discontinuity sets were determined by the software. In the context of discontinuity set selections, the familiar discontinuity orientations were groupped under individual sets (Table 4.1) and illustrated in Figure 4.2. In order to see the general distrubution of the discontinuities, the contur diagrams (Figure 4.3), pole consantrations (Figure 4.4) and rose diagrams (Figure 4.5) were plotted with the help of the software Dips 5.1.

Table 4.1. The orienatations of the major discontinuity sets observed at the study area

Set No	Dip	Dip Direction
1	67	203
2	77	350
3	67	043
4	66	096

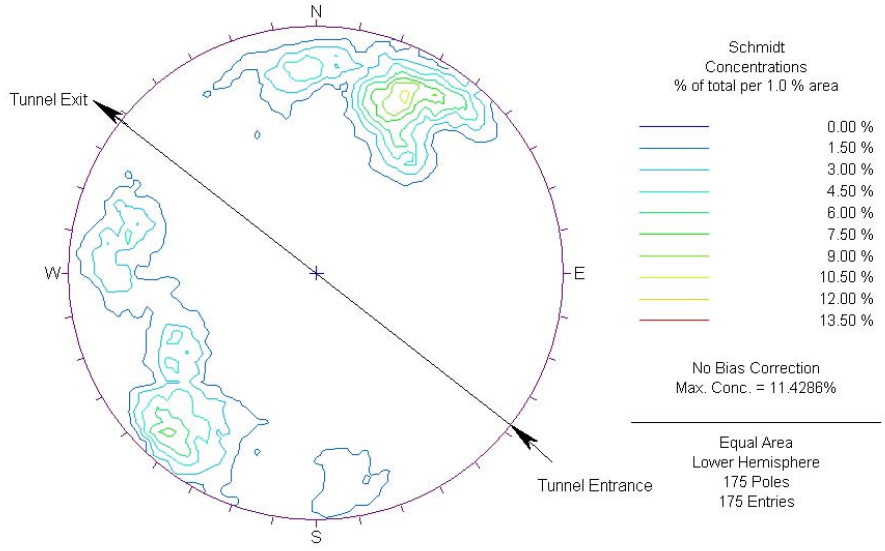

Figure 4.2. The contour diagram representing general distribution of the discontinuities at the study area. The black arrow indicates the direction of tunnel drive.

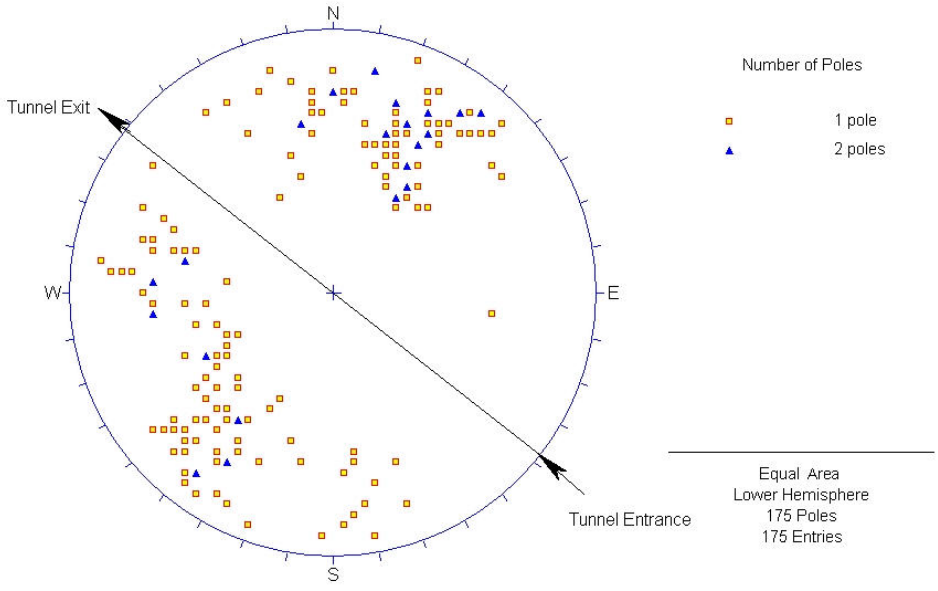

Figure 4.3. The pole consantration diagram of the discontinuities at the study area

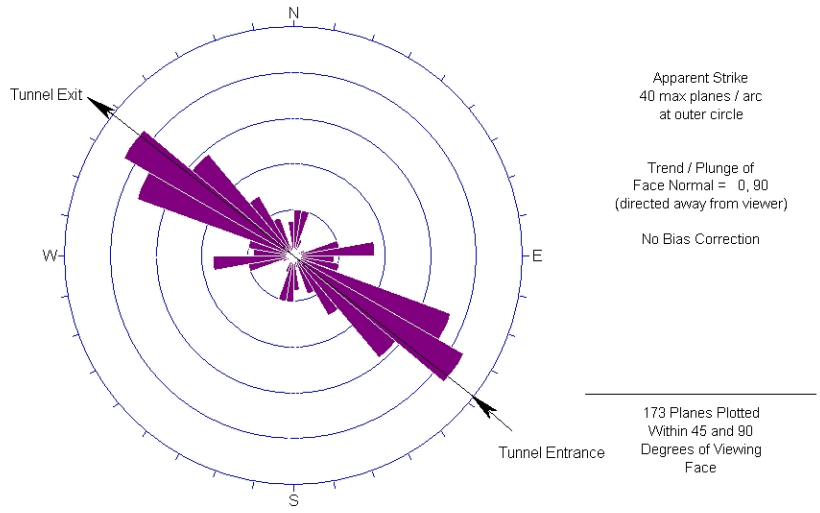

Figure 4.4 The Rosette diagram showing the trends of discontinuities

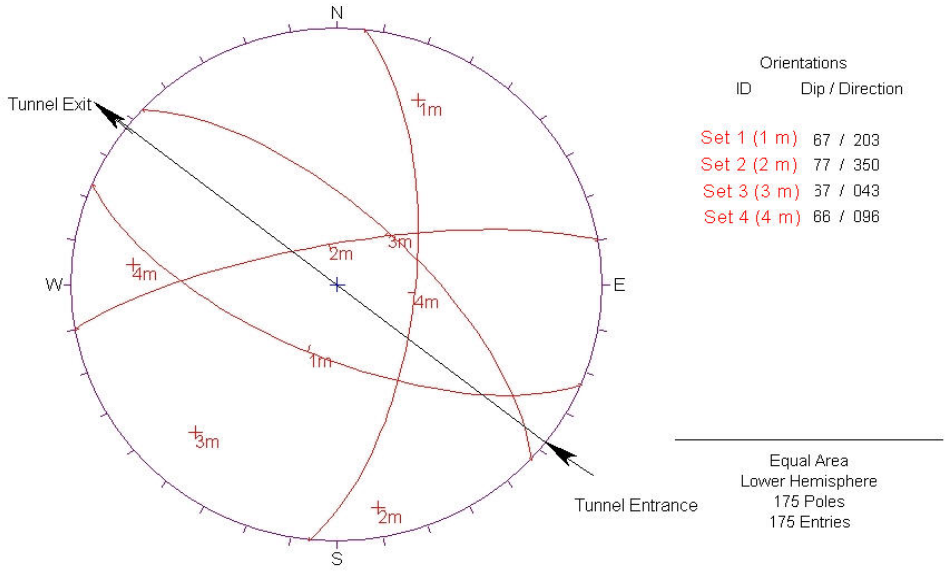

Figure 4.5 The illustration of dip/dip direction of the discontinuity sets

4.1.1.1. The New Ulus Tunnel Entrance Portal Kinematic Analyses

In the analyses, the dip angle for the portal rock slope was selected as 76° which is one of the steepest applicable excavation angle used in recent slope excavations. This angle denotes that the slope ratio is 1/4 (1 for horizontal and 4 for vertical). With the help of software (Dips 5.1), two major discontinuity sets revealed. The orienatation of these sets are given in Table 4.2 and represented in the dip/dip direction plot in Figure 4.9. Additionally, the plots of contour diagram (Figure 4.6), pole distrubution (Figure 4.7) and rose diagram (Figure 4.8) are given below. As for the appellation of set numbers, the familiar orientation of discontinuities were considered under the same set number.

Table 4.2 The orientations of major discontinuity sets at the entrance portal

Set Number	Dip	Dip Direction
1	73	207
3	68	047

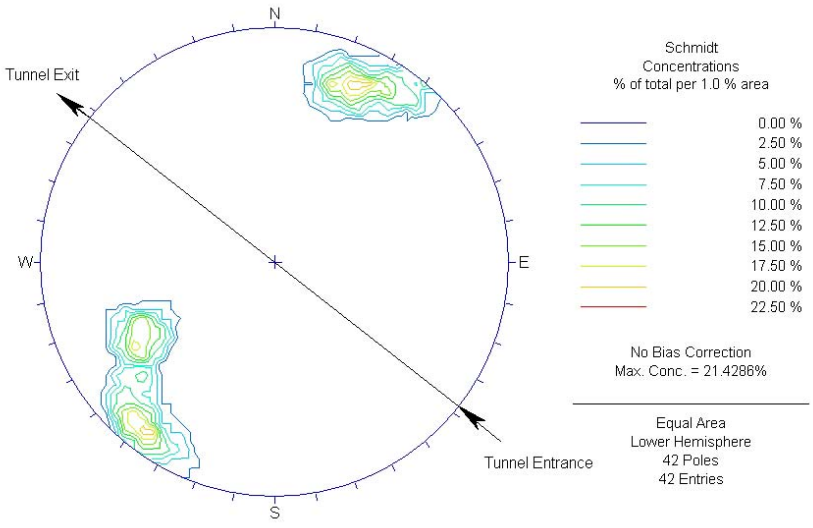

Figure 4.6 The contour plot of the discontinuities at km: 0+200-0+300

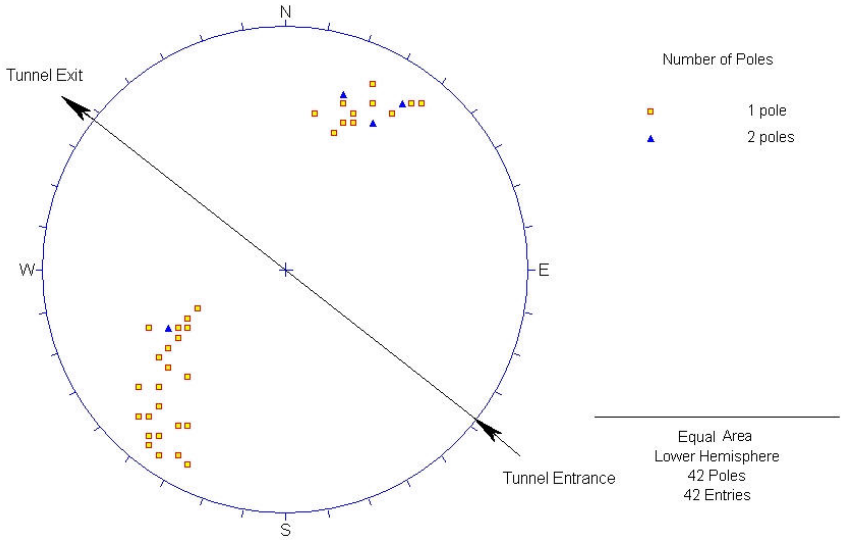

Figure 4.7. The pole plot of the discontinuities at km: 0+200-0+300

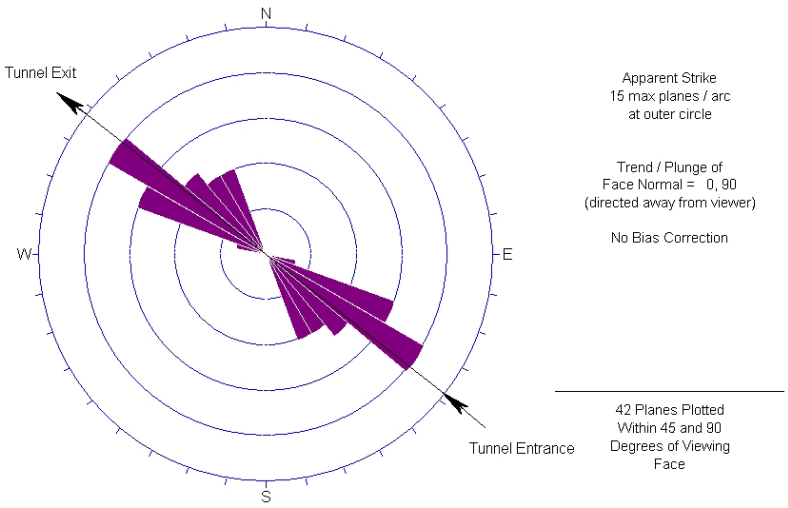

Figure 4.8. The rose diagram of the discontinuities at km: 0+200-0+300

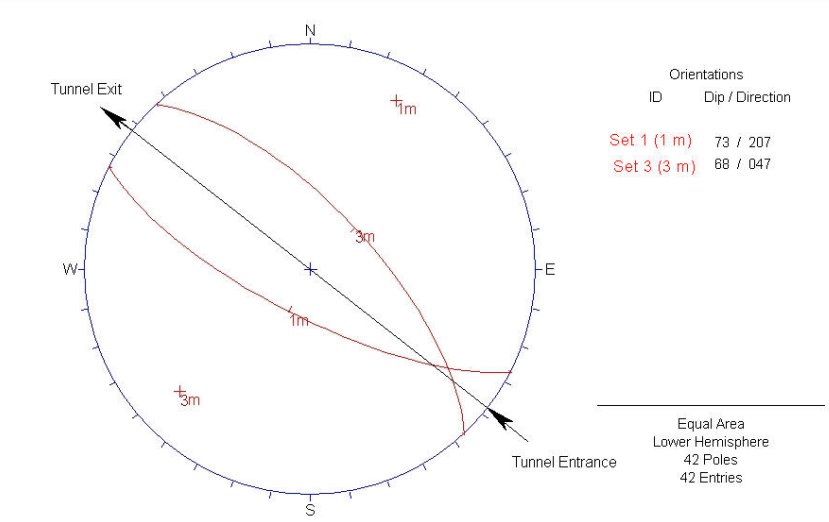

Figure 4.9. The orientation of major joint sets at km: 0+200-0+300

According to the kinematical analyses, there is not any potential for plane (Figure 4.10) and wedge failure (Figure 4.11) occurence. In addition toppling (Figure 4.12) is not expected at the rock slope. In the following illustrations of kinematical analyses, the yellow areas indicate the critical regions.

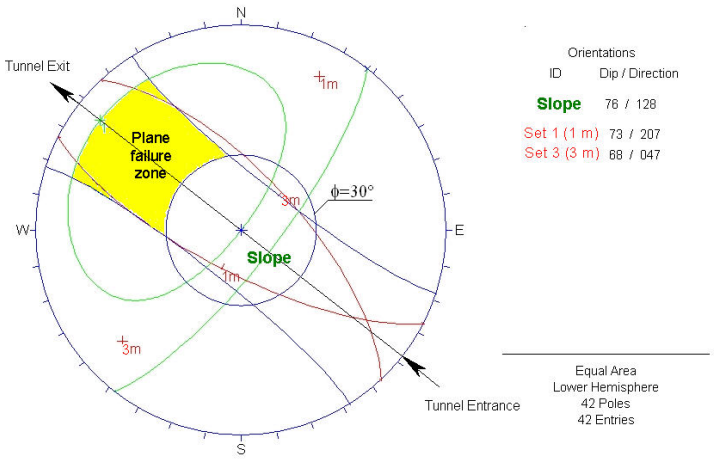

Figure 4.10 Plane failure analysis at the entrance portal rock slope

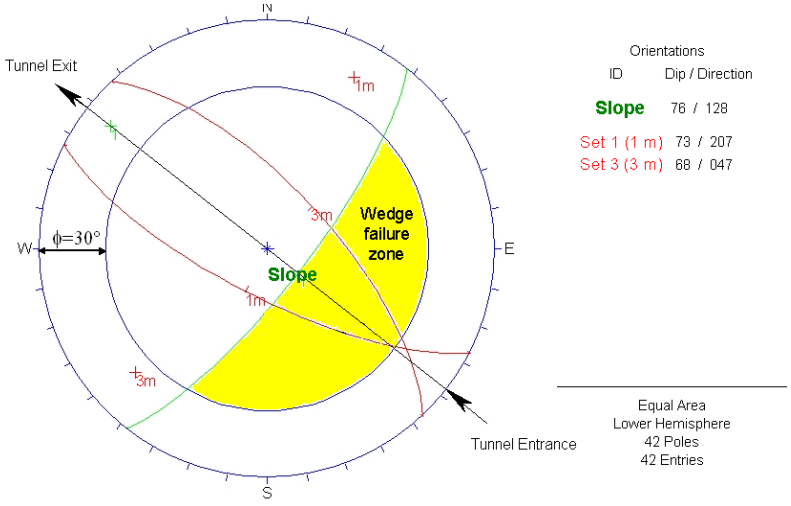

Figure 4.11 Wedge failure analysis at the entrance portal rock slope

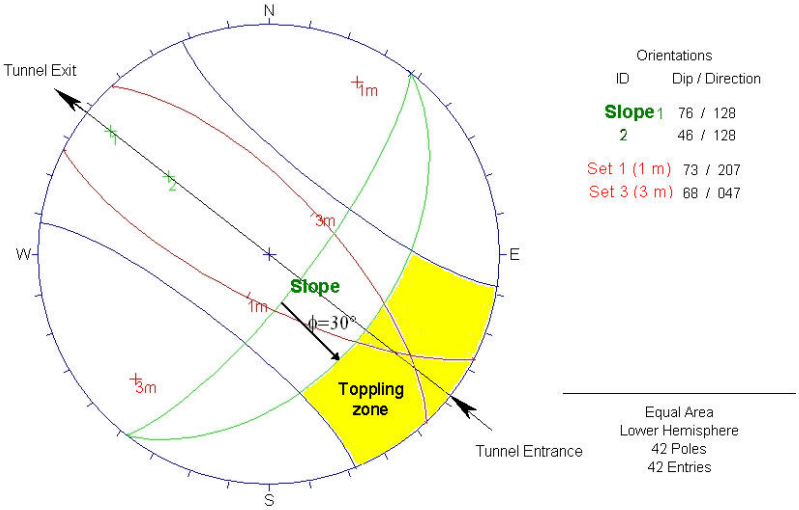

Figure 4.12 Toppling potential analysis at the entrance portal rock slope

As a result, the slope orientation 76/128 is safe for the entrance portal rock slope excavations. The kinematic analyses results are given in Table 4.3.

Table 4.3 Entrance portal slope kinematic analyses results

Dip/ Dip Direction of The Slope	Internal Friction Angle (ϕ)	Failure Type	Problem at Rock Slope	Stable Slope Angle
76/128	ϕ=30°	Plane	No	76/128
		Wedge	No	76/128
		Toppling	No	76/128

4.1.1.2. The New Ulus Tunnel Exit Portal Kinematic Analyses

For the kinematic analyses of exit portal rock slope, the same tunnel strike(308°), internal friction angle (30°) and slope angle (76°) were used. Since the exit portal falls in the chainage between 0+900-1+000, the site investigations near 0+900 were benefitted. According to the scan-line surveys at km:0+900, two major discontinuity sets were determined by the software. The orientations of these major sets are given in Table 4.4. and illustrated in Figure 4.16.

Table. 4.4. The orienatations of major discontinuity sets at the exit portal

Set Number	Dip	Dip Direction
1	68	205
3	66	036

The plots of contour diagram (Figure 4.13), pole concentration (Figure 4.14) and rose diagram (Figure 4.15) are given below.

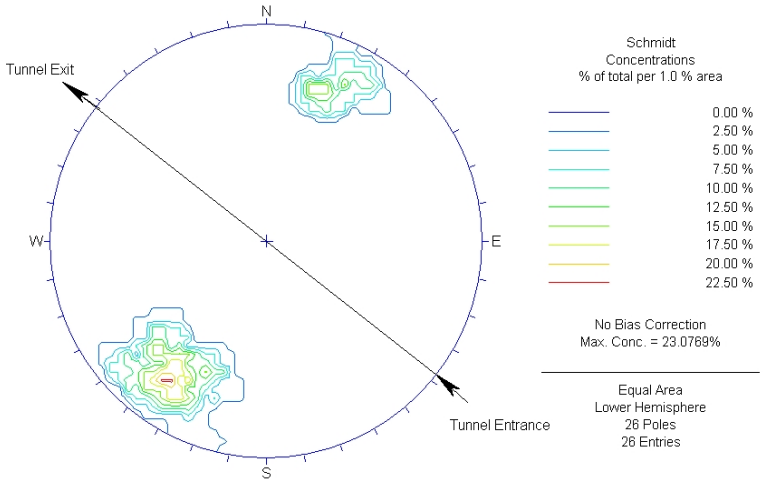

Figure 4.13. The contour diagram of discontinuities at km:0+900

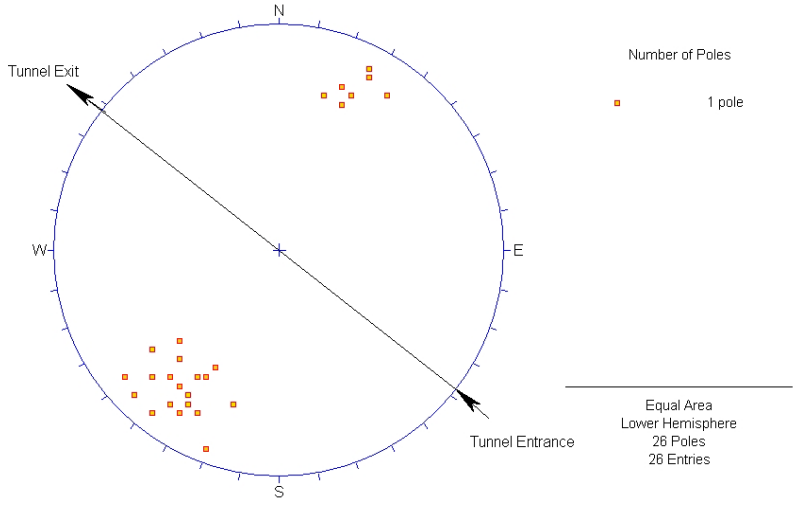

Figure 4.14 Pole concetration of discontinuities at km:0+900

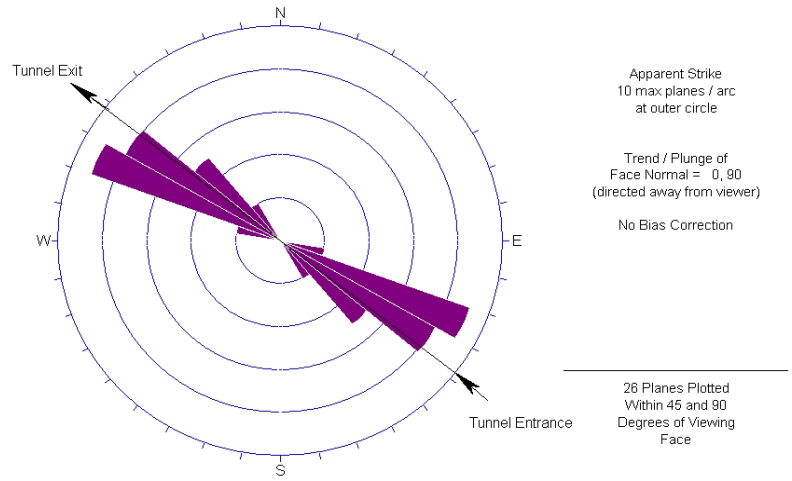

Figure 4.15. The rosette diagram of discontinuities at km:0+900

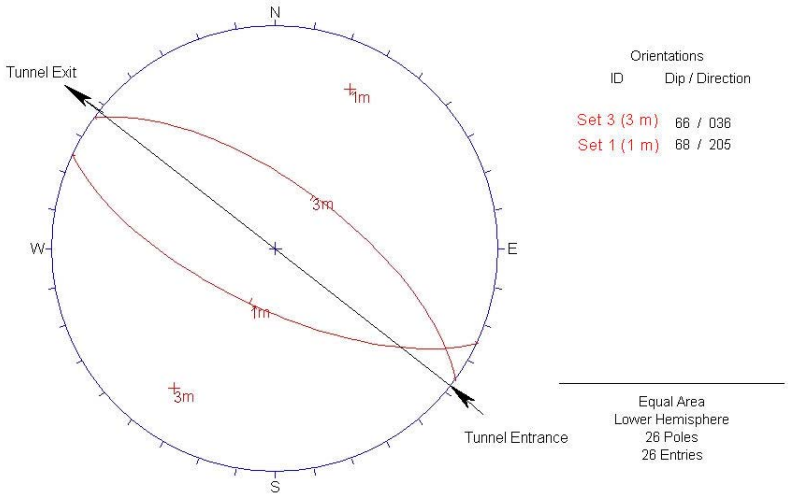

Figure 4.16 The orientations of major discontinuity sets at km:0+900

According to the kinematical analyses, any potential for the plane (Figure 4.17), wedge (Figure 4.18) failure and toppling (Figure 4.19) did not appear at the exit portal rock slope. Consequently the safe slope oriantation for the rock slope was determined as 76°/308°. The yellow areas shown in the figures indicate the critical regions.

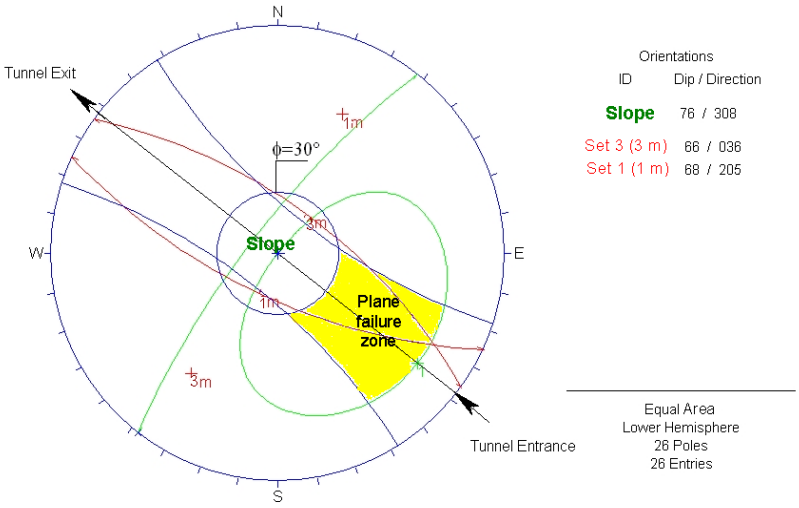

Figure 4.17 Plane failure analysis for the exit portal slope face

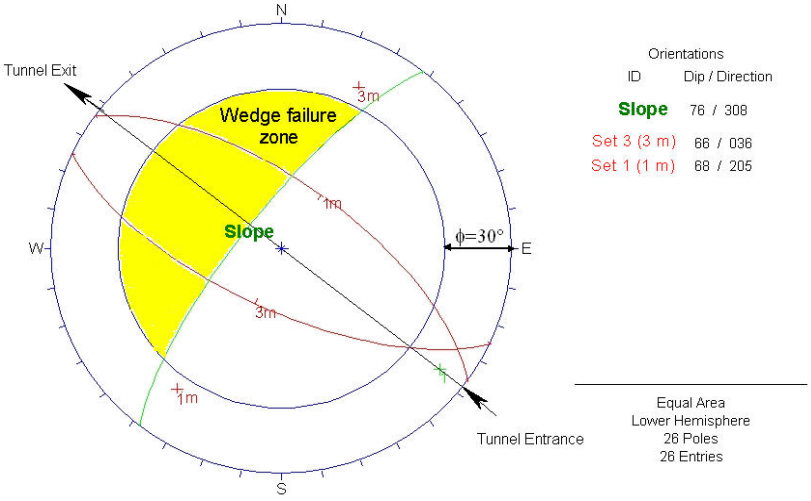

Figure 4.18 Wedge failure analysis for the exit portal rock slope face

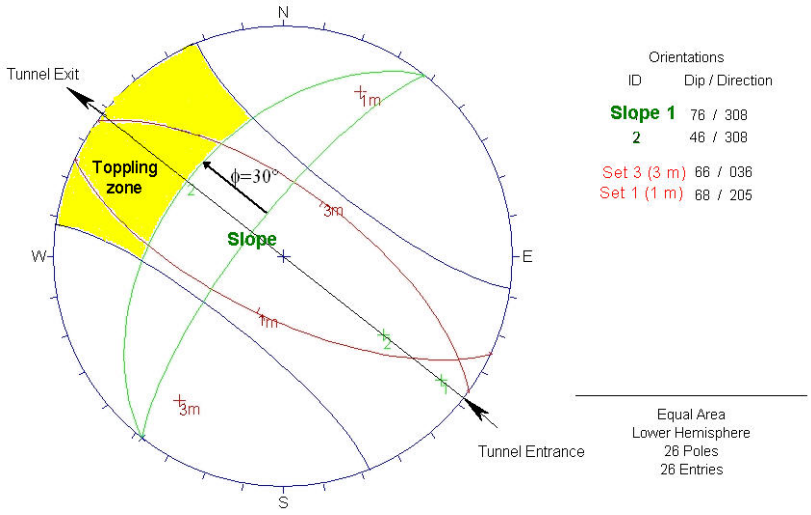

Figure 4.19 Toppling analysis for the exit portal rock slope face

The kinematical analyses revealed that the dip angle 76 is safe for the exit portal slopes. The results of slope stability analyses for the exit portal is given in table 4.5.

Table 4.5. Kinematical analyses results of rock slope at the exit portal

Dip/ Dip Direction of the Slope	**Internal Friction Angle (ϕ)**	**Failure Type**	**Problem at rock slope**	**Stable Slope Angle**
76°/308°	30°	Plane	No	76°/308°
		Wedge	No	
		Toppling	No	

The safe slope orientations obtained from the kinematical analyses are given in Table 4.6. In the case of portal slopes been excavated with the following orientations, any problem will not be encountered.

Table 4.6 The results of kinematical analyses applied on slopes at both entrance and exit portals

Portal	**Type Of Slope**	**Internal Friction Angle (Φ)**	**Problem**			**Stable Slope Angle (Dip/Dip Direction)**
			Plane	**Wedge**	**Toppling**	
The Entrance Portal	Rock Face Slope	30°	No	No	No	76/128
The Exit Portal	Rock Face Slope	30°	No	No	No	76/308

CHAPTER 5

SUPPORT SYSTEMS SUGGESTED FOR THE TUNNEL

Tunnel support systems are indispensable parts of the construction phase as well as the construction of tunnel itself. Essentially, any failure potential caused by stress distrubution around the tunnel is controlled by support systems. The only way of redusing that potential is the right selection of support systems.

For the selection of an efficent support, the stand-up time for the tunnel's unsupported span should be defined carefully. The geological unit's geomechanical properties are the key factors that determine the stand-up time for the tunnel span. In the case of tunnel drive into weak rock, a short stand - up time is expected. Under that circumstances the rock mass classifications gain importance.

5.1 Support systems depending on the RMR Classification

The appropriate rock reinforcement method is determined by making use of the guidelines that are mentioned below.

5.1.1 The Support Pressure

In the context of the excavation and support systems, guidelines in accordance with RMR system were generated. In-stu stress, shape of the tunnel and excavation method are the main factors effecting the guidelines of rock reinforcement. The support guidelines represents the permanent and not the

primary support. These guidelines presented in the Figure 5.1 are applicable to tunnelings using conventional drilling blasting procedures (Bieniawski, 1989).

Table 5.1. Guidelines for excavation and support of 10 m span rock tunnels in accordance with the *RMR* system (After Bieniawski 1989)*.

Rock mass class	Excavation	Rock bolts (20 mm diameter, fully grouted)	Shotcrete	Steel sets
I - Very good rock *RMR*: 81-100	Full face. 3 m advance.	Generally no support required except spot bolting.		
II - Good rock *RMR*: 61-80	Full face. 1-1.5 m advance. Complete support 20 m from face.	Locally, bolts in crown 3 m long, spaced 2.5 m with occasional wire mesh.	50 mm in crown where required.	None.
III - Fair rock *RMR*: 41-60	Top heading and bench 1.5-3 m advance in top heading. Commence support after each blast. Complete support 10 m from face.	Systematic bolts 4 m long, spaced 1.5 - 2 m in crown and walls with wire mesh in crown.	50-100 mm in crown and 30 mm in sides.	None.
IV - Poor rock *RMR*: 21-40	Top heading and bench 1.0-1.5 m advance in top heading. Install support concurrently with excavation, 10 m from face.	Systematic bolts 4-5 m long, spaced 1-1.5 m in crown and walls with wire mesh.	100-150 mm in crown and 100 mm in sides.	Light to medium ribs spaced 1.5 m where required.
V – Very poor rock *RMR*: < 20	Multiple drifts 0.5-1.5 m advance in top heading. Install support concurrently with excavation. Shotcrete as soon as possible after blasting.	Systematic bolts 5-6 m long, spaced 1-1.5 m in crown and walls with wire mesh. Bolt invert.	150-200 mm in crown, 150 mm in sides, and 50 mm on face.	Medium to heavy ribs spaced 0.75 m with steel lagging and forepoling if required. Close invert.

* Shape: horseshoe. Width: 10 m. Vertical stress: 25 MPa. Construction method: drilling and blasting.

Excluding BH-1 and BH-3, the borehole data were consulted in the support system determinations. The regions limited with red, blue and green lines represent the support catagories selected for the New Ulus Tunnel. Accordingly, for the region represented by BH 2, application of 4-5 m long rock bolts (spaced 1-1,5 m in crown) is recommended. As for the region represented by BH-4, application of systematic bolts which are 5-6 m long and spaced 1-1,5 m in crown is convenient.

With respect to the region represented by BH-6, application of systematic bolts which are 4-6 m long and spaced 1-1,5 m in crown are recommended. Regarding to the regions represented by BH-7 and BH-8, application of 4-5 m long rock bolts spaced 1-1,5 m in crown is recommended.

On the basis of coal mine studies Ünal (1983) proposed a correlation for the estimation of RMR aided support pressure of the opening with flat roof.

$$P_v = [(100 - RMR)/100] .\gamma. B \qquad \text{Eqn.1}$$

P_v: The support pressure, MPa

γ : The rock density, kN/m^3

B : The tunnel width, m

Table 5.2 Support pressures for The New Ulus Tunnel

Borehole No	RMR Rating	Density of the Rock (γ) kN/m^3	The tunnel Width (m)	Support Pressure (P_v) MPa
BH-2	23-33	23,60	12	0,218-0,19
BH-4	18-50	23,70	12	0,23-0,142
BH-5	22-50	23,00	12	0,215-0,138
BH-6	19-36	23,40	12	0,22-0,18
BH-7	23-42	23,10	12	0,21-0,16
BH-8	21-43	23,00	12	0,218-0,157

5.2 Support system according to the Q System

Using the Q system outputs, estimation of the stand-up time and the maximum unsupported span of the tunnel are obtained. The first step of support system determination is defining the equivalent dimension (D_e).

According to Barton's chart (Table 5.3), the excavation support ratio (ESR) for the New Ulus Tunnel is 1. The result gathered from the equation is as follows;

$$D_e = \text{Excavation Span}/ \text{ESR} \qquad \text{Eqn. 2}$$

$$D_e = 12/1 = 12$$

Table 5.3 Values of excavation support ratio-ESR (Barton et al., 1974)

Type of Excavation	ESR
Temporary mine openings, etc.	3 - 5
Vertical shafts: (i) circular section (ii) rectanular / square section	 2.5 2.0
Permanent mine openings, water tunnels for hydro power (excluding high pressure penstocks), pilot tunnels, drifts and headings for large excavations, etc.	1.6
Storage rooms, water treatment plants, minor road and railway tunnels, surge chambers, access tunnels, etc.	1.3
Oil storage caverns, power stations, major road and railway tunnels, civil defence chambers, portals, intersections, etc.	1.0
Underground nuclear power stations, railway stations, sports and public facilities, factories, etc.	0.8

In consideration of support systems, the length of bolt (L) is determined from the equation (Barton et. al.,1974) below;

$$L = (2+0{,}15B) / \text{ESR}, \ \text{m} \qquad \text{Eqn 3}$$

For the andesites observed at the borehole locations the following values are used;

$$L = (2+0{,}15x12) / 1 = 3{,}8 \text{ m}$$

The relation between equivalent dimension (D_e), tunneling quality index (Q) and support bolt length is presented in Figure 5.1 and the support categories for each observation location are summarized in the Table 5.4. The support systems selected for each borehole are represented by colored points in Figure 5.1.

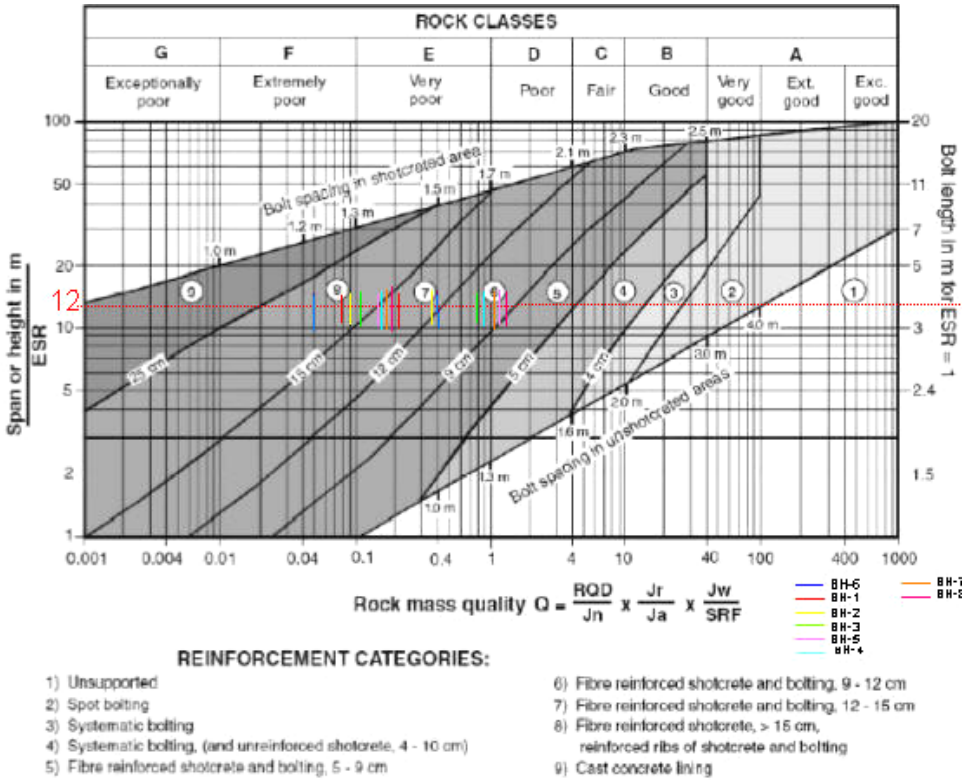

Figure 5.1. Estimated support categories based on the tunnelling quality index Q (After Grimstad and Barton, 1993, reproduced from Palmstrom and Broch, 2006).

Table 5.4. The reinforcement categories for each borehole location (according to Q system)

Borehole No	Q Index	D_e	Reinforcement Category
BH-2	0,09-0,38	12	8-7
BH-4	0,16-0,916	12	7-6
BH-5	0,16-1,15	12	7-6
BH-6	0,05-0,4	12	8-7
BH-7	0,18-1,18	12	7-6
BH-8	0,187-1,256	12	7-6

The reinforcement category gives the bolt spacing information in addition to the support type. According to the chart given in Figure 5.1, the following support categories were defined for the individual borehole locations. At km:0+255 and km:0+900 where BH-2 and BH-6 were drilled, 12-15 cm wide fibre reinforced shotcrete and 3,8 m rock bolting are recommended. For km:0+772 and km:0+840 where BH-4 and BH-5 were drilled, 9-12 cm or 12-15 cm wide fibre reinforced shotcrete and bolting (3,8 m rock bolt) method is advised. As for km:0+962 (BH-8) and km:0+970 (BH-7), application of 12-15 cm wide fibre reinforced shotcrete and 3,8 m long rock bolting is convenient.

Determination of the maximum unsupported span is achieved as follows:

$$\text{Maximum Unsupported Span} = 2(\text{ESR})\, Q^{0,4}\ , \text{m} \qquad \text{Eqn. 4}$$

For the andesites maximum unsupported span values are given in Table 5.5.

Table 5.5 Maximum unsupported span values for variable Q indexes of the andesites.

Borehole No	**Q Index**	**ESR**	**Max. Unsupported Span (m)**
BH-2	0,09-0,38	1	0,76-1,35
BH-4	0,16-0,91	1	0,96-1,93
BH-5	0,16-1,15	1	0,96-2,11
BH-6	0,05-0,4	1	0,6-1,38
BH-7	0,18-1,18	1	1,0-2,13
BH-8	0,18-1,25	1	1,0-2,18

CHAPTER 6

CONCLUSIONS

There are three main objectives of this thesis. The first objective involves the determination of the rock mass characteristics of the andesites that will host the New Ulus Tunnel. The second objective consists of defining the reliable support systems for the tunnel. The last objective comprises the assessment of the rock slope stabilities at the portals. In order to achieve these objectives, laboratory tests, detailed site investigations, classification systems and kinematical analyses have been utilized.

Throughout the tunnel alignment pink andesites of Mamak Formation (Miocene) constitute the main lithology. The andesites are jointed and moderately weathered. With respect to the petrographical analyses, biotite, hornblende and plagioclase minerals were defined as the major minerals whereas quartz and opaque minerals constitute the minor minerals. Futhermore, clay was observed within the microlith matrix. In addition, iron oxidation was determined which also confirms that andesites are weathered.

Depending on the scan-line surveys, four major discontinuity sets with orientations of 67/203; 77/350; 37/043; 66/096 and random joints were revealed at the study area. Since the investigated region is mostly covered with houses, site investigation results of previous studies were also benefited. In general, the discontinuity surfaces are moderately weathered and filled with clay. Moreover, sand occurences were identified within some discontinuities. Close to the surface, staining (iron oxidation) along discontinuity surfaces is noted. As for the discontinuity conditions, the spacing of the discontinuities ranges between 45 mm

and 1400 mm. Besides, the apartures of the discontinuities range between 1 mm-15 mm.

Based on the the results of empirical classification systems (RMR and Q system), the andesites exhibit very poor to fair rock qualities. This change in rock mass quality is assumed to occur due to the variaty of discontinuity conditions and alteration. Especially the fluctuation of the uniaxial compressive strengths within close distances indicates that there is a differantiation of andesites internal structure. Due to the laboratory test results, the uniaxial compressive strength of the andesites range between 6,46 Mpa and 56,06 Mpa. The dry unit weight of andesites has an interval of 21,47-23,43 kN/m^3 .

The kinematical analyses indicate that there is no potential for any type of failure at the entrance and exit portal rock slopes. Through the analyses, the stable slope orientations for the entrance portal was defined as 76/128 (dip/dip direction). Regarding to the exit portal rock slope, the stable orientation was defined as 76/308 (dip/dip direction).

As for the tunnel support systems, application of 9-12 cm or 12-15 cm wide fibre reinforced shotcrete and rock bolts (3,8 m long rock bolt) are recommended.

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APPENDIX A

The scan-line survey charts (I.S.R.M, 1981)

DISCONTINUITY MEASUREMENT FORM

PROJECT NAME : The New Ulus Tunnel — DATE : 2008

PREPARED BY : İrem Aksular — PAGE : 1 / 5

LOCATION :

KILOMETER	CUT NO	TYPE	DIP (°)	DIP DIRECTION (°)	SPACING	APERTURE	PERSISTENCE	ROUGNESS		FILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOGY
0+200		3	53	060	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	58	064	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	62	042	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	45	065	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	57	064	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	65	055	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	52	058	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	49	062	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	54	059	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	62	066	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	65	050	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	60	056	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	67	192	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	62	200	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	74	198	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	70	204	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	68	204	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	76	207	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	71	200	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	65	202	3-4	5-6	3	c	4	3	2	3	And	Andesite
0+300		3	70	210	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	75	216	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	69	211	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	74	200	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	80	205	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	82	218	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	79	214	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	81	215	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	82	220	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	84	025	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	78	042	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	75	050	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	81	038	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	85	039	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	76	043	3-4	5-6	3	c	4	3	2	3	And	Andesite

DISCONTINUITY DESCRIPTIONS (ISRM,1981)

TYPE
1 FAULT ZONE
2 FAULT
3 JOINT
4 CLEAVAGE
5 SCHISTOSITY
6 SHEAR
7 FRACTURE
8 BED

ROUGNESS
A STEPPED
B UNDULATING
C PLANAR
1 SLICKENSIDED
2 SMOOTH
3 SLIGHTLY ROUGH
4 ROUGH
5 VERY ROUGH

FILLNG TYPE
1 OPEN
2 SURFACE STAINING
3 CLAY
4 BRECCIA
5 MINERAL
6 CEMENTATION
7 CHLORITE,TALC,GYPSUM

SPACING

	mm
1 EXTREMELY CLOSE	<20
2 VERY CLOSE	20-60
3 CLOSE	60-200
4 MODERATE	200-600
5 WIDE	600-2000
6 VERY WIDE	2000-6000
7 EXTREMELY WIDE	>6000

PERSİSTENCE
1 VERY LOW
2 LOW
3 MEDIUM
4 HIGH
5 VERY HIGH

m	SEEPAGE
<1	1 DRY
1-3	2 DAMP
3-10	3 WET
10-20	4 DRIPPING
	5 FLOWING

WEATHERING
1 FRESH
2 SLIGHTLY WEARHERED
3 MODERATELY WEATHERED
4 HIGHLY WEATHERED
5 COMPLETELY WEATHERED
6 DECOMPOSED

APERTURE

		mm
1 VERY TIGHT	CLOSED	<0.1
2 TIGHT		0.1-0.25
3 PARTLY OPEN		0.25-0.5
4 OPEN	GAPPED	0.5-2.5
5 MODERATELY WIDE		2.5-10
6 WIDE		>10
7 VERY WIDE	OPEN	10-100
8 A.EXTREMELY WIDE		100-1000
9 CAVERNOUS		>1000

Continued

DISCONTINUITY MEASUREMENT FORM

PROJECT NAME	: The New Ulus Tunnel	DATE :	2008
PREPARED BY	: İrem Aksular	PAGE :	2 / 5
LOCATION	:		

KILOMETER	CUT NO	TYPE	DIP (°)	DIP DIRECTION (°)	SPACING	APERTURE	PERSISTENCE	ROUGNESS		FILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOGY
0+300		3	83	040	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	80	045	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	70	047	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	74	032	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	76	035	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	82	031	3-4	5-6	3	c	4	3	2	3	And	Andesite
		3	85	036	3-4	5-6	3	c	4	3	2	3	And	Andesite
0+400		3	84	224	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	82	220	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	79	225	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	75	220	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	77	223	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	76	220	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	71	104	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	73	105	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	78	125	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	77	115	3-5	4-6	3	c	4	3	2	2-3	And	Andesite
		3	81	192	2-3	1-2	3	c	4	1	1	1-2	And	Andesite
		3	44	152	3	4	3	c	4	3	1	2	And	Andesite
		3	72	182	3-4	6	3	c	4	3	1	3	And	Andesite
		3	62	172	4	6	3	c	4	3	1	3	And	Andesite
		3	74	180	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	75	180	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	74	175	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	80	180	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	72	173	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	68	175	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	66	171	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	56	162	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	50	165	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	66	170	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	69	173	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	74	183	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	75	185	3-4	6	2	c	4	3-4	1	2	And	Andesite
		3	80	192	3-4	4-6	3	c	4	3	2	2-3	And	Andesite

DISCONTINUITY DESCRIPTIONS (ISRM,1981)

TYPE
1 FAULT ZONE
2 FAULT
3 JOINT
4 CLEAVAGE
5 SCHISTOSITY
6 SHEAR
7 FRACTURE
8 BED

ROUGNESS
A STEPPED
B UNDULATING
C PLANAR
1 SLICKENSIDED
2 SMOOTH
3 SLIGHTLY ROUGH
4 ROUGH
5 VERY ROUGH

FILLING TYPE
1 OPEN
2 SURFACE STAINING
3 CLAY
4 BRECCIA
5 MINERAL
6 CEMENTATION
7 CHLORITE,TALC,GYPSUM

SPACING

	mm
1 EXTREMELY CLOSE	<20
2 VERY CLOSE	20-60
3 CLOSE	60-200
4 MODERATE	200-600
5 WIDE	600-2000
6 VERY WIDE	2000-6000
7 EXTREMELY WIDE	>6000

APERTURE

		mm
1 VERY TIGHT	CLOSED	<0.1
2 TIGHT		0.1-0.25
3 PARTLY OPEN		0.25-0.5
4 OPEN	GAPPED	0.5-2.5
5 MODERATELY WIDE		2.5-10
6 WIDE		>10
7 VERY WIDE	OPEN	10-100
8 EXTREMELY WIDE		100-1000
9 CAVERNOUS		>1000

PERSİSTENCE
1 VERY LOW
2 LOW
3 MEDIUM
4 HIGH
5 VERY HIGH

m	SEEPAGE
<1	1 DRY
1-3	2 DAMP
3-10	3 WET
10-20	4 DRIPPING
	5 FLOWING

WEATHERING
1 FRESH
2 SLIGHTLY WEARHERED
3 MODERATELY WEATHERED
4 HIGHLY WEATHERED
5 COMPLETELY WEATHERED
6 DECOMPOSED

Continued

DISCONTINUITY MEASUREMENT FORM

PROJECT NAME	: The New Ulus Tunnel	DATE :	2008
PREPARED BY	: İrem Aksular	PAGE :	3 / 5
LOCATION	:		

KILOMETER	CUT NO	TYPE	DIP (°)	DIP DIRECTION (°)	SPACING	APERTURE	PERSISTENCE	ROUGNESS		FILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOGY
0+400		3	86	200	3-4	4-6	3	c	4	3	2	2-3	And	Andesite
0+600		3	61	104	4	5-6	3	c	4	3	2	3	And	Andesite
		3	58	107	4	5-6	3	c	4	3	2	3	And	Andesite
		3	66	110	4	5-6	3	c	4	3	2	3	And	Andesite
		3	71	105	4	5-6	3	c	4	3	2	3	And	Andesite
		3	69	114	4	5-6	3	c	4	3	2	3	And	Andesite
		3	59	102	4	5-6	3	c	4	3	2	3	And	Andesite
		3	60	100	4	5-6	3	c	4	3	2	3	And	Andesite
		3	65	011	4	5-6	3	c	4	3	2	3	And	Andesite
		3	62	105	4	5-6	3	c	4	3	2	3	And	Andesite
		3	48	067	4	5-6	3	c	4	3	2	3	And	Andesite
		3	64	278	4	5-6	3	c	4	3	2	3	And	Andesite
		3	68	083	4	5-6	3	c	4	3	2	3	And	Andesite
		3	59	085	4	5-6	3	c	4	3	2	3	And	Andesite
		3	82	358	4	5-6	3	c	4	3	2	3	And	Andesite
		3	48	076	4	5-6	3	c	4	3	2	3	And	Andesite
		3	85	003	4	5-6	3	c	4	3	2	3	And	Andesite
		3	64	352	4	5-6	3	c	4	3	2	3	And	Andesite
		3	68	083	4	5-6	3	c	4	3	2	3	And	Andesite
		3	76	048	4	5-6	3	c	4	3	2	3	And	Andesite
		3	74	349	4	5-6	3	c	4	3	2	3	And	Andesite
		3	77	351	4	5-6	3	c	4	3	2	3	And	Andesite
		3	65	352	4	5-6	3	c	4	3	2	3	And	Andesite
		3	85	350	4	5-6	3	c	4	3	2	3	And	Andesite
		3	45	094	4	5-6	3	c	4	3	2	3	And	Andesite
		3	81	340	4	5-6	3	c	4	3	2	3	And	Andesite
		3	70	040	4	5-6	3	c	4	3	2	3	And	Andesite
		3	75	048	4	5-6	3	c	4	3	2	3	And	Andesite
		3	80	052	4	5-6	3	c	4	3	2	3	And	Andesite
		3	65	046	4	5-6	3	c	4	3	2	3	And	Andesite
		3	81	165	4	5-6	3	c	4	3	2	3	And	Andesite
		3	77	160	4	5-6	3	c	4	3	2	3	And	Andesite
		3	78	169	4	5-6	3	c	4	3	2	3	And	Andesite
		3	52	084	4	5-6	3	c	4	3	2	3	And	Andesite
		3	56	079	4	5-6	3	c	4	3	2	3	And	Andesite

DISCONTINUITY DESCRIPTIONS (ISRM,1981)

TYPE
1 FAULT ZONE
2 FAULT
3 JOINT
4 CLEAVAGE
5 SCHISTOSITY
6 SHEAR
7 FRACTURE
8 BED

ROUGNESS
A STEPPED
B UNDULATING
C PLANAR
1 SLICKENSIDED
2 SMOOTH
3 SLIGHTLY ROUGH
4 ROUGH
5 VERY ROUGH

FILLING TYPE
1 OPEN
2 SURFACE STAINING
3 CLAY
4 BRECCIA
5 MINERAL
6 CEMENTATION
7 CHLORITE,TALC,GYPSUM

SPACING — mm
1 EXTREMELY CLOSE — <20
2 VERY CLOSE — 20-60
3 CLOSE — 60-200
4 MODERATE — 200-600
5 WIDE — 600-2000
6 VERY WIDE — 2000-6000
7 EXTREMELY WIDE — >6000

APERTURE — mm
CLOSED: 1 VERY TIGHT <0.1; 2 TIGHT 0.1-0.25; 3 PARTLY OPEN 0.25-0.5
GAPPED: 4 OPEN 0.5-2.5; 5 MODERATELY WIDE 2.5-10; 6 WIDE >10
OPEN: 7 VERY WIDE 10-100; 8 A.EXTREMELY WIDE 100-1000; 9 CAVERNOUS >1000

PERSİSTENCE
1 VERY LOW
2 LOW
3 MEDIUM
4 HIGH
5 VERY HIGH

m / SEEPAGE
<1 — 1 DRY
1-3 — 2 DAMP
3-10 — 3 WET
10-20 — 4 DRIPPING
5 FLOWING

WEATHERING
1 FRESH
2 SLIGHTLY WEARHERED
3 MODERATELY WEATHERED
4 HIGHLY WEATHERED
5 COMPLETELY WEATHERED
6 DECOMPOSED

Continued

DISCONTINUITY MEASUREMENT FORM

PROJECT NAME	: The New Ulus Tunnel	DATE :	2008
PREPARED BY	: İrem Aksular	PAGE :	4/5
LOCATION	:		

KILOMETER	CUT NO	TYPE	DIP (°)	DIP DIRECTION (°)	SPACING	APERTURE	PERSISTENCE	ROUGNESS		FILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOGY
0+600		3	70	340	4	5-6	3	c	4	3	2	3	And	Andesite
		3	81	354	4	5-6	3	c	4	3	2	3	And	Andesite
		3	69	355	4	5-6	3	c	4	3	2	3	And	Andesite
0+840		3	80	145	4	5-6	3	c	4	3	2	2	And	Andesite
		3	78	152	4	5-6	3	c	4	3	2	2	And	Andesite
		3	69	154	4	5-6	3	c	4	3	2	2	And	Andesite
		3	64	210	2-4	4	3	c	4	3	1	2	And	Andesite
		3	60	212	2	4-5	3	c	4	3	1	2	And	Andesite
		3	58	209	2-4	4-5	3	c	4	3	1	2	And	Andesite
		3	54	215	2	4-5	3	c	4	3	1	2	And	Andesite
		3	46	215	2	4-5	3	c	4	3	1	2	And	Andesite
		3	52	230	4	7-8	3	c	4	3	1	2	And	Andesite
		3	42	216	4-5	4	4	c	4	3	1	2	And	Andesite
		3	54	218	4-5	4-5	4	c	4	3	1	2	And	Andesite
		3	52	216	4-5	5	3-4	c	4	3	1	2	And	Andesite
		3	50	224	6	6	3-4	c	4	3	1	2	And	Andesite
		3	75	095	5	4	2	c	4	2	1	2	And	Andesite
		3	78	096	5	4	2	c	4	2	1	2	And	Andesite
		3	70	092	5	4	2	c	4	2	1	2	And	Andesite
		3	69	087	5	4	2	c	4	2	1	2	And	Andesite
		3	72	089	5	4	2	c	4	2	1	2	And	Andesite
		3	80	095	5	4	2	c	4	2	1	2	And	Andesite
		3	84	097	5	4	2	c	4	2	1	2	And	Andesite
		3	70	094	5	4	2	c	4	2	1	2	And	Andesite
		3	68	215	4-5	6-7	4	c	4	3	1	2-3	And	Andesite
		3	55	200	4-5	6-7	3	c	4	3	1	3	And	Andesite
		3	75	230	4-5	6	4	c	4	3	1	2-3	And	Andesite
		3	76	235	4-5	6	4	c	4	3	1	2-3	And	Andesite
		3	72	210	4-5	6	4	c	4	3	1	2-3	And	Andesite
		3	70	205	4-5	6	4	c	4	3	1	2-3	And	Andesite
		3	67	210	4-5	6	4	c	4	3	1	2-3	And	Andesite
		3	75	212	4-5	6	4	c	4	3	1	2-3	And	Andesite
		3	78	207	4-5	6	4	c	4	3	1	2-3	And	Andesite
		3	65	200	4-5	6	4	c	4	3	1	2-3	And	Andesite
		3	60	192	4-5	6	4	c	4	3	1	2-3	And	Andesite

DISCONTINUITY DESCRIPTIONS (ISRM,1981)

TYPE
1 FAULT ZONE
2 FAULT
3 JOINT
4 CLEAVAGE
5 SCHISTOSITY
6 SHEAR
7 FRACTURE
8 BED

ROUGNESS
A STEPPED
B UNDULATING
C PLANAR
1 SLICKENSIDED
2 SMOOTH
3 SLIGHTLY ROUGH
4 ROUGH
5 VERY ROUGH

FILLING TYPE
1 OPEN
2 SURFACE STAINING
3 CLAY
4 BRECCIA
5 MINERAL
6 CEMENTATION
7 CHLORITE,TALC,GYPSUM

SPACING — mm
1 EXTREMELY CLOSE — <20
2 VERY CLOSE — 20-60
3 CLOSE — 60-200
4 MODERATE — 200-600
5 WIDE — 600-2000
6 VERY WIDE — 2000-6000
7 EXTREMELY WIDE — >6000

APERTURE — mm
CLOSED: 1 VERY TIGHT — <0.1; 2 TIGHT — 0.1-0.25; 3 PARTLY OPEN — 0.25-0.5
GAPPED: 4 OPEN — 0.5-2.5; 5 MODERATELY WIDE — 2.5-10; 6 WIDE — >10
OPEN: 7 VERY WIDE — 10-100; 8 A.EXTREMELY WIDE — 100-1000; 9 CAVERNOUS — >1000

PERSİSTENCE
1 VERY LOW
2 LOW
3 MEDIUM
4 HIGH
5 VERY HIGH

m	SEEPAGE
<1	1 DRY
1-3	2 DAMP
3-10	3 WET
10-20	4 DRIPPING
	5 FLOWING

WEATHERING
1 FRESH
2 SLIGHTLY WEARHERED
3 MODERATELY WEATHERED
4 HIGHLY WEATHERED
5 COMPLETELY WEATHERED
6 DECOMPOSED

Continued

DISCONTINUITY MEASUREMENT FORM

PROJECT NAME	: The New Ulus Tunnel	DATE :	2008
PREPARED BY	: İrem Aksular	PAGE :	5 / 5
LOCATION	:		

KILOMETER	CUT NO	TYPE	DIP (°)	DIP DIRECTION (°)	SPACING	APERTURE	PERSISTENCE	ROUGNESS		FILLING TYPE	SEEPAGE	WEATHERING	SYMBOL	LITHOLOGY
		3	60	037	3	3	1	c	4	3	1	2	And	Andesite
		3	48	205	2-4	4	3	c	4	3	1	2	And	Andesite
		3	55	205	2-4	4	3	c	4	3	1	2	And	Andesite
		3	64	200	2-4	4	3	c	4	3	1	2	And	Andesite
		3	61	204	2-4	4	3	c	4	3	1	2	And	Andesite
		3	59	210	2-4	4	3	c	4	3	1	2	And	Andesite
		3	50	218	2-4	4	3	c	4	3	1	2	And	Andesite
		3	47	215	2-4	4	3	c	4	3	1	2	And	Andesite
		3	53	204	2-4	4	3	c	4	3	1	2	And	Andesite
0+900		3	59	017	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	58	033	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	78	050	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	85	020	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	72	036	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	64	041	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	60	050	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	55	028	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	69	030	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	66	032	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	70	025	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	50	026	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	62	037	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	68	046	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	74	032	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	77	045	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	81	038	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	54	043	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	50	049	3-4	5-6	3	c	4	3	2	2	And	Andesite
		3	76	208	5	6	4	c	4	3	1	2-3	And	Andesite
		3	63	204	5	6	4	c	4	3	1	2-3	And	Andesite
		3	67	200	5	6	4	c	4	3	1	2-3	And	Andesite
		3	71	215	5	6	4	c	4	3	1	2-3	And	Andesite
		3	80	207	5	6	4	c	4	3	1	2-3	And	Andesite
		3	59	202	5	6	4	c	4	3	1	2-3	And	Andesite
		3	60	197	5	6	4	c	4	3	1	2-3	And	Andesite

DISCONTINUITY DESCRIPTIONS (ISRM,1981)

TYPE
1 FAULT ZONE
2 FAULT
3 JOINT
4 CLEAVAGE
5 SCHISTOSITY
6 SHEAR
7 FRACTURE
8 BED

ROUGNESS
A STEPPED
B UNDULATING
C PLANAR
1 SLICKENSIDED
2 SMOOTH
3 SLIGHTLY ROUGH
4 ROUGH
5 VERY ROUGH

FILLING TYPE
1 OPEN
2 SURFACE STAINING
3 CLAY
4 BRECCIA
5 MINERAL
6 CEMENTATION
7 CHLORITE,TALC,GYPSUM

SPACING

	mm
1 EXTREMELY CLOSE	<20
2 VERY CLOSE	20-60
3 CLOSE	60-200
4 MODERATE	200-600
5 WIDE	600-2000
6 VERY WIDE	2000-6000
7 EXTREMELY WIDE	>6000

APERTURE

		mm
1 VERY TIGHT	CLOSED	<0.1
2 TIGHT	CLOSED	0.1-0.25
3 PARTLY OPEN	CLOSED	0.25-0.5
4 OPEN	GAPPED	0.5-2.5
5 MODERATELY WIDE	GAPPED	2.5-10
6 WIDE	GAPPED	>10
7 VERY WIDE	OPEN	10-100
8 AEXTREMELY WIDE	OPEN	100-1000
9 CAVERNOUS	OPEN	>1000

PERSİSTENCE
1 VERY LOW
2 LOW
3 MEDIUM
4 HIGH
5 VERY HIGH

m	SEEPAGE
<1	1 DRY
1-3	2 DAMP
3-10	3 WET
10-20	4 DRIPPING
	5 FLOWING

WEATHERING
1 FRESH
2 SLIGHTLY WEARHERED
3 MODERATELY WEATHERED
4 HIGHLY WEATHERED
5 COMPLETELY WEATHERED
6 DECOMPOSED

APPENDIX B

Classification of individual parameters used in Q System (Barton et. Al.,1974)

DESCRIPTION	VALUE	NOTES
1. ROCK QUALITY DESIGNATION	*RQD*	
A. Very poor	0 - 25	1. Where *RQD* is reported or measured as ≤ 10 (including 0),
B. Poor	25 - 50	a nominal value of 10 is used to evaluate Q.
C. Fair	50 - 75	
D. Good	75 - 90	2. *RQD* intervals of 5, i.e. 100, 95, 90 etc. are sufficiently
E. Excellent	90 - 100	accurate.
2. JOINT SET NUMBER	J_n	
A. Massive, no or few joints	0.5 - 1.0	
B. One joint set	2	
C. One joint set plus random	3	
D. Two joint sets	4	
E. Two joint sets plus random	6	
F. Three joint sets	9	1. For intersections use $(3.0 \times J_n)$
G. Three joint sets plus random	12	
H. Four or more joint sets, random,	15	2. For portals use $(2.0 \times J_n)$
heavily jointed, 'sugar cube', etc.		
J. Crushed rock, earthlike	20	
3. JOINT ROUGHNESS NUMBER	J_r	
a. Rock wall contact		
b. Rock wall contact before 10 cm shear		
A. Discontinuous joints	4	
B. Rough and irregular, undulating	3	
C. Smooth undulating	2	
D. Slickensided undulating	1.5	1. Add 1.0 if the mean spacing of the relevant joint set is
E. Rough or irregular, planar	1.5	greater than 3 m.
F. Smooth, planar	1.0	
G. Slickensided, planar	0.5	2. J_r = 0.5 can be used for planar, slickensided joints having
c. No rock wall contact when sheared		lineations, provided that the lineations are oriented for
H. Zones containing clay minerals thick	1.0	minimum strength.
enough to prevent rock wall contact	(nominal)	
J. Sandy, gravely or crushed zone thick	1.0	
enough to prevent rock wall contact	(nominal)	
4. JOINT ALTERATION NUMBER	J_a	ϕr degrees (approx.)
a. Rock wall contact		
A. Tightly healed, hard, non-softening,	0.75	1. Values of ϕr, the residual friction angle,
impermeable filling		are intended as an approximate guide
B. Unaltered joint walls, surface staining only	1.0	25 - 35 to the mineralogical properties of the
C. Slightly altered joint walls, non-softening	2.0	25 - 30 alteration products, if present.
mineral coatings, sandy particles, clay-free		
disintegrated rock, etc.		
D. Silty-, or sandy-clay coatings, small clay-	3.0	20 - 25
fraction (non-softening)		
E. Softening or low-friction clay mineral coatings,	4.0	8 - 16
i.e. kaolinite, mica. Also chlorite, talc, gypsum		
and graphite etc., and small quantities of swelling		
clays. (Discontinuous coatings, 1 - 2 mm or less)		

Continued

4. JOINT ALTERATION NUMBER	J_a	ϕr degrees (approx.)	
b. Rock wall contact before 10 cm shear			
F. Sandy particles, clay-free, disintegrating rock etc.	4.0	25 - 30	
G. Strongly over-consolidated, non-softening clay mineral fillings (continuous < 5 mm thick)	6.0	16 - 24	
H. Medium or low over-consolidation, softening clay mineral fillings (continuous < 5 mm thick)	8.0	12 - 16	
J. Swelling clay fillings, i.e. montmorillonite, (continuous < 5 mm thick). Values of J_a depend on percent of swelling clay-size particles, and access to water.	8.0 - 12.0	6 - 12	
c. No rock wall contact when sheared			
K. Zones or bands of disintegrated or crushed	6.0		
L. rock and clay (see G, H and J for clay	8.0		
M. conditions)	8.0 - 12.0	6 - 24	
N. Zones or bands of silty- or sandy-clay, small clay fraction, non-softening	5.0		
O. Thick continuous zones or bands of clay	10.0 - 13.0		
P. & R. (see G.H and J for clay conditions)	6.0 - 24.0		
5. JOINT WATER REDUCTION	J_w	approx. water pressure (kgf/cm^2)	
A. Dry excavation or minor inflow i.e. < 5 l/m locally	1.0	< 1.0	
B. Medium inflow or pressure, occasional outwash of joint fillings	0.66	1.0 - 2.5	
C. Large inflow or high pressure in competent rock with unfilled joints	0.5	2.5 - 10.0	1. Factors C to F are crude estimates; increase J_w if drainage installed.
D. Large inflow or high pressure	0.33	2.5 - 10.0	
E. Exceptionally high inflow or pressure at blasting, decaying with time	0.2 - 0.1	> 10	2. Special problems caused by ice formation are not considered.
F. Exceptionally high inflow or pressure	0.1 - 0.05	> 10	
6. STRESS REDUCTION FACTOR		*SRF*	
a. Weakness zones intersecting excavation, which may cause loosening of rock mass when tunnel is excavated			
A. Multiple occurrences of weakness zones containing clay or chemically disintegrated rock, very loose surrounding rock any depth)		10.0	1. Reduce these values of *SRF* by 25 - 50% but only if the relevant shear zones influence do not intersect the excavation
B. Single weakness zones containing clay, or chemically disintegrated rock (excavation depth < 50 m)		5.0	
C. Single weakness zones containing clay, or chemically disintegrated rock (excavation depth > 50 m)		2.5	
D. Multiple shear zones in competent rock (clay free), loose surrounding rock (any depth)		7.5	
E. Single shear zone in competent rock (clay free). (depth of excavation < 50 m)		5.0	
F. Single shear zone in competent rock (clay free). (depth of excavation > 50 m)		2.5	
G. Loose open joints, heavily jointed or 'sugar cube', (any depth)		5.0	

Continued

DESCRIPTION	VALUE			NOTES
6. STRESS REDUCTION FACTOR			***SRF***	
b. Competent rock, rock stress problems				
	σ_c/σ_1	$\sigma_t\sigma_1$		2. For strongly anisotropic virgin stress field
H. Low stress, near surface	> 200	> 13	2.5	(if measured): when $5 \le \sigma_1/\sigma_3 \le 10$, reduce σ_c
J. Medium stress	200 - 10	13 - 0.66	1.0	to $0.8\sigma_c$ and σ_t to $0.8\sigma_t$. When σ_1/σ_3 > 10,
K. High stress, very tight structure	10 - 5	0.66 - 0.33	0.5 - 2	reduce σ_c and σ_t to $0.6\sigma_c$ and $0.6\sigma_t$, where
(usually favourable to stability, may				σ_c = unconfined compressive strength, and
be unfavourable to wall stability)				σ_t = tensile strength (point load) and σ_1 and
L. Mild rockburst (massive rock)	5 - 2.5	0.33 - 0.16	5 - 10	σ_3 are the major and minor principal stresses.
M. Heavy rockburst (massive rock)	< 2.5	< 0.16	10 - 20	3. Few case records available where depth of
c. Squeezing rock, plastic flow of incompetent rock				crown below surface is less than span width.
under influence of high rock pressure				Suggest *SRF* increase from 2.5 to 5 for such
N. Mild squeezing rock pressure			5 - 10	cases (see H).
O. Heavy squeezing rock pressure			10 - 20	
d. Swelling rock, chemical swelling activity depending on presence of water				
P. Mild swelling rock pressure			5 - 10	
R. Heavy swelling rock pressure			10 - 15	

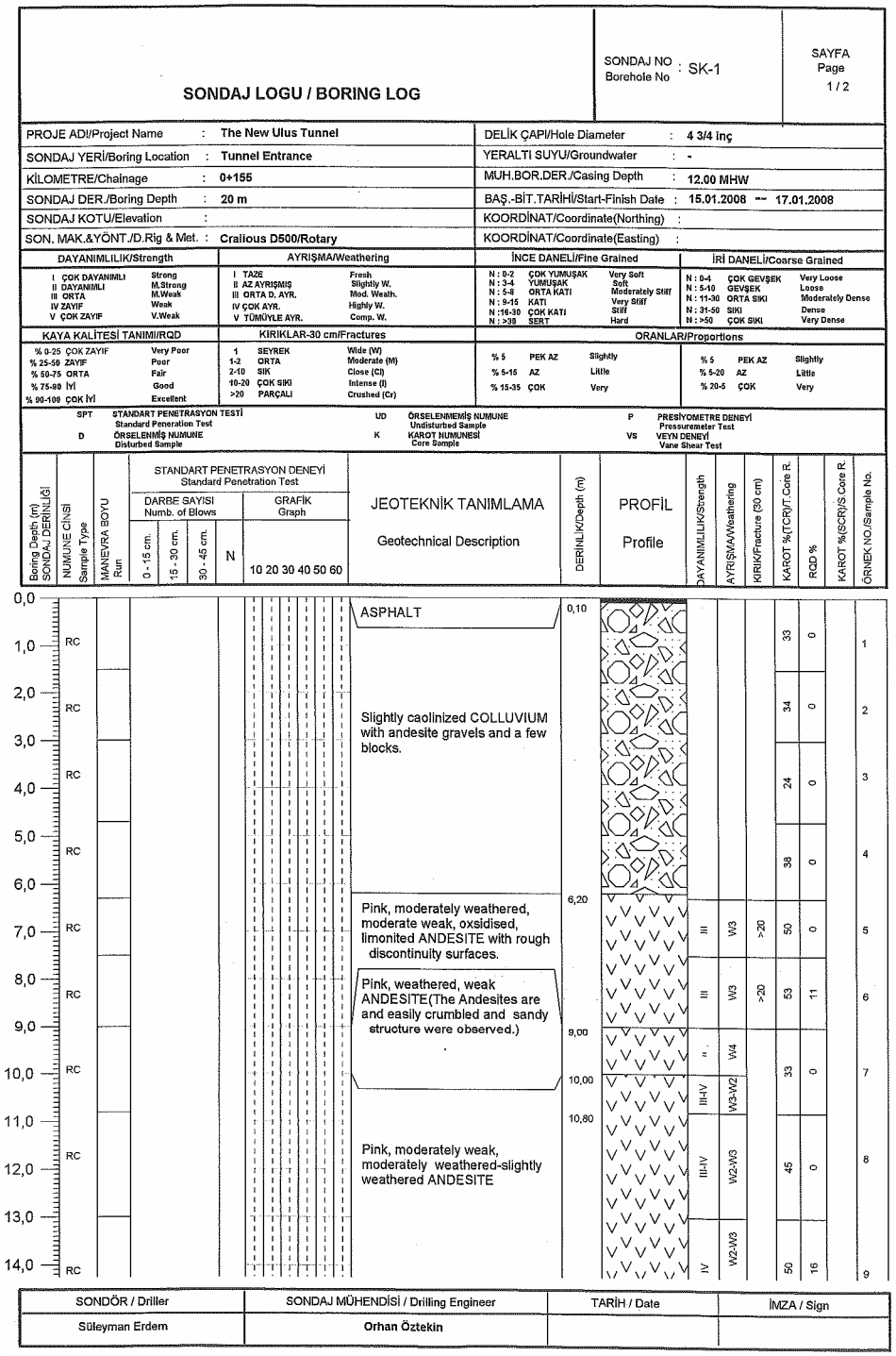
ADDITIONAL NOTES ON THE USE OF THESE TABLES

When making estimates of the rock mass Quality (Q), the following guidelines should be followed in addition to the notes listed in the tables:

1. When borehole core is unavailable, *RQD* can be estimated from the number of joints per unit volume, in which the number of joints per metre for each joint set are added. A simple relationship can be used to convert this number to *RQD* for the case of clay free rock masses: $RQD = 115 - 3.3\ J_v$ (approx.), where J_v = total number of joints per m^3 ($0 < RQD < 100$ for $35 > J_v > 4.5$).
2. The parameter J_n representing the number of joint sets will often be affected by foliation, schistosity, slaty cleavage or bedding etc. If strongly developed, these parallel 'joints' should obviously be counted as a complete joint set. However, if there are few 'joints' visible, or if only occasional breaks in the core are due to these features, then it will be more appropriate to count them as 'random' joints when evaluating J_n.
3. The parameters J_r and J_a (representing shear strength) should be relevant to the weakest significant joint set or clay filled discontinuity in the given zone. However, if the joint set or discontinuity with the minimum value of J_r/J_a is favourably oriented for stability, then a second, less favourably oriented joint set or discontinuity may sometimes be more significant, and its higher value of J_r/J_a should be used when evaluating Q. The value of J_r/J_a should in fact relate to the surface most likely to allow failure to initiate.
4. When a rock mass contains clay, the factor *SRF* appropriate to loosening loads should be evaluated. In such cases the strength of the intact rock is of little interest. However, when jointing is minimal and clay is completely absent, the strength of the intact rock may become the weakest link, and the stability will then depend on the ratio rock-stress/rock-strength. A strongly anisotropic stress field is unfavourable for stability and is roughly accounted for as in note 2 in the table for stress reduction factor evaluation.
5. The compressive and tensile strengths (σ_c and σ_t) of the intact rock should be evaluated in the saturated condition if this is appropriate to the present and future in situ conditions. A very conservative estimate of the strength should be made for those rocks that deteriorate when exposed to moist or saturated conditions.

APPENDIX C

The borehole logs



SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-1

SAYFA / Page 1 / 2

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Tunnel Entrance	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+155	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 20 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 15.01.2008 -- 17.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained			İRİ DANELİ/Coarse Grained		
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2	ÇOK YUMUŞAK	Very Soft	N : 0-4	ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4	YUMUŞAK	Soft	N : 5-10	GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8	ORTA KATI	Moderately Stiff	N : 11-30	ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15	KATI	Very Stiff	N : 31-50	SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N : 16-30	ÇOK KATI	Stiff	N : >50	ÇOK SIKI	Very Dense
				N : >30	SERT	Hard			

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions					
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)						
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)						

SPT	STANDART PENETRASYON TESTİ / Standard Peneration Test	UD	ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample	P	PRESİYOMETRE DENEYİ / Pressuremeter Test
D	ÖRSELENMİŞ NUMUNE / Disturbed Sample	K	KAROT NUMUNESİ / Core Sample	VS	VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows (0 - 15 cm., 15 - 30 cm., 30 - 45 cm., N)	GRAFİK / Graph (10 20 30 40 50 60)	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T. Core R.	RQD %	KAROT %(SCR)/S Core R.	ÖRNEK NO./Sample No.
0,0														
1,0	RC				ASPHALT	0,10					33	0		1
2,0	RC				Slightly caolinized COLLUVIUM with andesite gravels and a few blocks.						34	0		2
3,0	RC										24	0		3
4,0	RC										38	0		4
5,0	RC													
6,0	RC				Pink, moderately weathered, moderate weak, oxsidised, limonited ANDESITE with rough discontinuity surfaces.	6,20		III	W3	>20	50	0		5
7,0	RC				Pink, weathered, weak ANDESITE(The Andesites are and easily crumbled and sandy structure were observed.)			III	W3	>20	53	11		6
8,0	RC					9,00		"	W4					
9,0	RC					10,00		III-IV	W3-W2		33	0		7
10,0	RC					10,80								
11,0	RC				Pink, moderately weak, moderately weathered-slightly weathered ANDESITE			III-IV	W2-W3		45	0		8
12,0	RC													
13,0	RC							IV	W2-W3		50	16		9
14,0	RC													

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
Süleyman Erdem	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-1

SAYFA / Page 2 / 2

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Tunnel Entrance	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+155	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 20 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 15.01.2008 -- 17.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI Strong II DAYANIMLI M.Strong III ORTA M.Weak IV ZAYIF Weak V ÇOK ZAYIF V.Weak	I TAZE Fresh II AZ AYRIŞMIŞ Slightly W. III ORTA D. AYR. Mod. Weath. IV ÇOK AYR. Highly W. V TÜMÜYLE AYR. Comp. W.	N : 0-2 ÇOK YUMUŞAK Very Soft N : 3-4 YUMUŞAK Soft N : 5-8 ORTA KATI Moderately Stiff N : 9-15 KATI Very Stiff N :16-30 ÇOK KATI Stiff N : >30 SERT Hard	N : 0-4 ÇOK GEVŞEK Very Loose N : 5-10 GEVŞEK Loose N : 11-30 ORTA SIKI Moderately Dense N : 31-50 SIKI Dense N : >50 ÇOK SIKI Very Dense

KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF Very Poor % 25-50 ZAYIF Poor % 50-75 ORTA Fair % 75-90 İYİ Good % 90-100 ÇOK İYİ Excellent	1 SEYREK Wide (W) 1-2 ORTA Moderate (M) 2-10 SIK Close (Cl) 10-20 ÇOK SIKI Intense (I) >20 PARÇALI Crushed (Cr)	% 5 PEK AZ Slightly % 5-15 AZ Little % 15-35 ÇOK Very	% 5 PEK AZ Slightly % 5-20 AZ Little % 20-5 ÇOK Very

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm. / 15 - 30 cm. / 30 - 45 cm. / N; GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T. Core R.	RQD %	KAROT %(SCR)/S. Core R.	ÖRNEK NO./Sample No.
15,0													
16,0	RC			Pink,moderately weak, moderately weathered-slightly weathered ANDESITE with rough, oxidised and limonited discontinuity surfaces.			IV	W2-W3		83	27		10
17,0	RC			The andesite partly exhibits cooling cracks at an angle of 85 degrees.			IV	W2-W3		69	7		11
18,0													
19,0	RC			Pink, highly weathered, weak ANDESITE	19,50		III	W4		68	8		12
20,0				The end of Borehole	20,00								
21,0													
22,0													
23,0													
24,0													
25,0													
26,0													
27,0													
28,0													

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
Süleyman Erdem	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-2

SAYFA / Page 1 / 4

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+265/ Serpme Street	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+265	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 18.01.2008 -- 24.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI — Strong II DAYANIMLI — M.Strong III ORTA — M.Weak IV ZAYIF — Weak V ÇOK ZAYIF — V.Weak	I TAZE — Fresh II AZ AYRIŞMIŞ — Slightly W. III ORTA D. AYR. — Mod. Weath. IV ÇOK AYR. — Highly W. V TÜMÜYLE AYR. — Comp. W.	N : 0-2 ÇOK YUMUŞAK — Very Soft N : 3-4 YUMUŞAK — Soft N : 5-8 ORTA KATI — Moderately Stiff N : 9-15 KATI — Very Stiff N : 16-30 ÇOK KATI — Stiff N : >30 SERT — Hard	N : 0-4 ÇOK GEVŞEK — Very Loose N : 5-10 GEVŞEK — Loose N : 11-30 ORTA SIKI — Moderately Dense N : 31-50 SIKI — Dense N : >50 ÇOK SIKI — Very Dense

KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF — Very Poor % 25-50 ZAYIF — Poor % 50-75 ORTA — Fair % 75-90 İYİ — Good % 90-100 ÇOK İYİ — Excellent	1 SEYREK — Wide (W) 1-2 ORTA — Moderate (M) 2-10 SIK — Close (Cl) 10-20 ÇOK SIKI — Intense (I) >20 PARÇALI — Crushed (Cr)	% 5 PEK AZ — Slightly % 5-15 AZ — Little % 15-35 ÇOK — Very	% 5 PEK AZ — Slightly % 5-20 AZ — Little % 20-5 ÇOK — Very

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test — DARBE SAYISI Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
0,0																	
1,0	RC							ASPHALT	0,10		I	W4		33	0		1
2,0	RC							Pink, highly weathered, very weak ANDESITE showing sandy structure			I	W4		32	0		2
3,0	RC										I	W4		30	0		3
4,0	RC								4,30		IV	W4					
5,0	RC							Pink, slightly weathered-fresh, moderate strong, ANDESITE						75	62		4
6,0	RC							The discontinuity surfaces are rough and clean.						60	31		5
7,0	RC													93	38		6
8,0	RC													58	14		7
9,0	RC										IV	W2-W1		60	17		8
10,0	RC													77	49		9
11,0	RC																
12,0	RC													55	31		10
13,0																	
14,0	RC																

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
Süleyman Erdem	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-2

SAYFA / Page 2 / 4

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+265/ Serpme Street	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+265	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 18.01.2008 -- 24.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength

I ÇOK DAYANIMLI	Strong
II DAYANIMLI	M.Strong
III ORTA	M.Weak
IV ZAYIF	Weak
V ÇOK ZAYIF	V.Weak

AYRIŞMA/Weathering

I TAZE	Fresh
II AZ AYRIŞMIŞ	Slightly W.
III ORTA D. AYR.	Mod. Weath.
IV ÇOK AYR.	Highly W.
V TÜMÜYLE AYR.	Comp. W.

İNCE DANELİ/Fine Grained

N : 0-2	ÇOK YUMUŞAK	Very Soft
N : 3-4	YUMUŞAK	Soft
N : 5-8	ORTA KATI	Moderately Stiff
N : 9-15	KATI	Very Stiff
N :16-30	ÇOK KATI	Stiff
N : >30	SERT	Hard

İRİ DANELİ/Coarse Grained

N : 0-4	ÇOK GEVŞEK	Very Loose
N : 5-10	GEVŞEK	Loose
N : 11-30	ORTA SIKI	Moderately Dense
N : 31-50	SIKI	Dense
N : >50	ÇOK SIKI	Very Dense

KAYA KALİTESİ TANIMI/RQD

% 0-25 ÇOK ZAYIF	Very Poor
% 25-50 ZAYIF	Poor
% 50-75 ORTA	Fair
% 75-90 İYİ	Good
% 90-100 ÇOK İYİ	Excellent

KİRİKLAR-30 cm/Fractures

1	SEYREK	Wide (W)
1-2	ORTA	Moderate (M)
2-10	SIK	Close (Cl)
10-20	ÇOK SIKI	Intense (I)
>20	PARÇALI	Crushed (Cr)

ORANLAR/Proportions

% 5	PEK AZ	Slightly
% 5-15	AZ	Little
% 15-35	ÇOK	Very
% 5	PEK AZ	Slightly
% 5-20	AZ	Little
% 20-5	ÇOK	Very

SPT	STANDART PENETRASYON TESTİ Standard Peneration Test	UD	ÖRSELENMEMİŞ NUMUNE Undisturbed Sample	P	PRESİYOMETRE DENEYİ Pressuremeter Test
D	ÖRSELENMİŞ NUMUNE Disturbed Sample	K	KAROT NUMUNESİ Core Sample	VS	VEYN DENEYİ Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T. Core R.	RQD %	KAROT %(SCR)/S. Core R.	ÖRNEK NO./Sample No.
15,0																	
16,0																	
17,0	RC										IV	W2-W1		31	0		11
18,0																	
19,0	RC										IV	W2-W1		56	27		12
20,0								Pink, slightly weathered-fresh, moderate strong, ANDESITE									
21,0								The discontinuity surfaces are rough and clean.									
22,0	RC										IV	W2-W1		55	42		13
23,0																	
24,0																	
25,0	RC										IV	W2-W1		67	24		14
26,0																	
27,0	RC										IV	W2-W1		68	12		15
28,0	RC										IV	W2-W1		79	10		16

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
Süleyman Erdem	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-2

SAYFA / Page 3 / 4

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+265/ Serpme Street	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+265	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 18.01.2008 -- 24.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Crallous D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained			İRİ DANELİ/Coarse Grained		
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2	ÇOK YUMUŞAK	Very Soft	N : 0-4	ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4	YUMUŞAK	Soft	N : 5-10	GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8	ORTA KATI	Moderately Stiff	N : 11-30	ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15	KATI	Very Stiff	N : 31-50	SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30	ÇOK KATI	Stiff	N : >50	ÇOK SIKI	Very Dense
				N : >30	SERT	Hard			

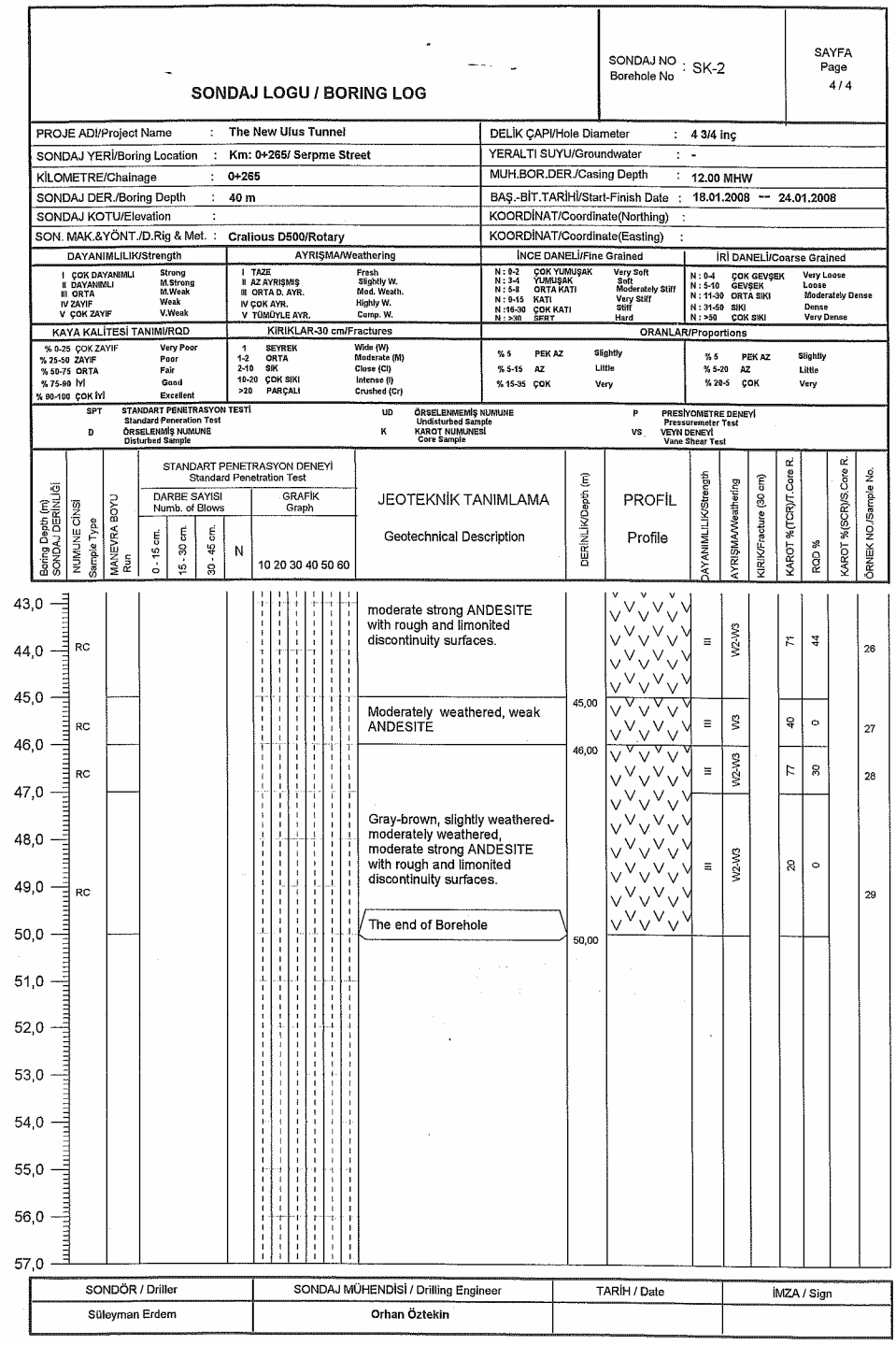
KAYA KALİTESİ TANIMI/RQD		KIRIKLAR 30 cm/Fractures			ORANLAR/Proportions					
% 0-25 ÇOK ZAYIF	Very Poor	1	SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2	ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75 ORTA	Fair	2-10	SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90 İYİ	Good	10-20	ÇOK SIKI	Intense (I)						
% 90-100 ÇOK İYİ	Excellent	>20	PARÇALI	Crushed (Cr)						

SPT	STANDART PENETRASYON TESTİ Standard Peneration Test	UD	ÖRSELENMEMİŞ NUMUNE Undisturbed Sample	P	PRESİYOMETRE DENEYİ Pressuremeter Test
D	ÖRSELENMİŞ NUMUNE Disturbed Sample	K	KAROT NUMUNESİ Core Sample	VS	VEYN DENEYİ Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows (0 - 15 cm. / 15 - 30 cm. / 30 - 45 cm. / N)	GRAFİK Graph (10 20 30 40 50 60)	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T. Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
29,0	RC													
30,0	RC							IV	W2-W1		60	24		17
31,0	RC							IV	W2-W1		80	41		18
32,0	RC							IV	W2-W1		82	37		19
33,0	RC				Pink, slightly weathered-fresh, moderate strong, ANDESITE									
34,0	RC				The discontinuity surfaces are rough and clean.			IV	W2-W1		80	29		20
35,0	RC							IV	W2-W1		51	29		21
36,0	RC							IV	W2-W1		80	31		22
37,0	RC							IV	W2-W1		67	44		23
38,0	RC							IV	W2-W1					
39,0	RC													
40,0	RC					40,00		III	W2-W3		70	21		24
41,0	RC				Gray-brown, slightly weathered-moderately weathered,			III	W2-W3		54	35		25
42,0														

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
Süleyman Erdem	Orhan Öztekin		

Continued



SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-2

SAYFA / Page 4 / 4

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+265/ Serpme Street	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+265	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 18.01.2008 -- 24.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI Strong II DAYANIMLI M.Strong III ORTA M.Weak IV ZAYIF Weak V ÇOK ZAYIF V.Weak	I TAZE Fresh II AZ AYRIŞMIŞ Slightly W. III ORTA D. AYR. Mod. Weath. IV ÇOK AYR. Highly W. V TÜMÜYLE AYR. Comp. W.	N : 0-2 ÇOK YUMUŞAK Very Soft N : 3-4 YUMUŞAK Soft N : 5-8 ORTA KATI Moderately Stiff N : 9-15 KATI Very Stiff N :16-30 ÇOK KATI Stiff N : >30 SERT Hard	N : 0-4 ÇOK GEVŞEK Very Loose N : 5-10 GEVŞEK Loose N : 11-30 ORTA SIKI Moderately Dense N : 31-50 SIKI Dense N : >50 ÇOK SIKI Very Dense

KAYA KALİTESİ TANIMI/RQD	KİRİKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF Very Poor % 25-50 ZAYIF Poor % 50-75 ORTA Fair % 75-90 İYİ Good % 90-100 ÇOK İYİ Excellent	1 SEYREK Wide (W) 1-2 ORTA Moderate (M) 2-10 SIK Close (Cl) 10-20 ÇOK SIKI Intense (I) >20 PARÇALI Crushed (Cr)	% 5 PEK AZ Slightly % 5-15 AZ Little % 15-35 ÇOK Very	% 5 PEK AZ Slightly % 5-20 AZ Little % 20-5 ÇOK Very

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm. / 15 - 30 cm. / 30 - 45 cm. / N; GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
43,0													
44,0	RC			moderate strong ANDESITE with rough and limonited discontinuity surfaces.			III	W2-W3		71	44		26
45,0	RC			Moderately weathered, weak ANDESITE	45,00		III	W3		40	0		27
46,0	RC				46,00		III	W2-W3		77	30		28
47,0				Gray-brown, slightly weathered-moderately weathered, moderate strong ANDESITE with rough and limonited discontinuity surfaces.			III	W2-W3		20	0		29
48,0													
49,0	RC												
50,0				The end of Borehole	50,00								
51,0													
52,0													
53,0													
54,0													
55,0													
56,0													
57,0													

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
Süleyman Erdem	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-3

SAYFA / Page 1 / 3

PROJE Adı/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+490	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+490	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 10.01.2008 "" 15.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained		İRİ DANELİ/Coarse Grained	
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2 ÇOK YUMUŞAK	Very Soft	N : 0-4 ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4 YUMUŞAK	Soft	N : 5-10 GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8 ORTA KATI	Moderately Stiff	N : 11-30 ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15 KATI	Very Stiff	N : 31-50 SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30 ÇOK KATI	Stiff	N : >50 ÇOK SIKI	Very Dense
				N : >30 SERT	Hard		

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions					
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)						
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)						

SPT	STANDART PENETRASYON TESTİ Standard Peneration Test	UD	ÖRSELENMEMİŞ NUMUNE Undisturbed Sample	P	PRESİYOMETRE DENEYİ Pressuremeter Test
D	ÖRSELENMİŞ NUMUNE Disturbed Sample	K	KAROT NUMUNESİ Core Sample	VS	VEYN DENEYİ Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISİ Numb. of Blows (0 - 15 cm. / 15 - 30 cm. / 30 - 45 cm. / N)	GRAFİK Graph (10 20 30 40 50 60)	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
0,0														
1,0	RC				Pink, completely weathered, weak-very weak ANDESITE Sand occurance was observed.			I-II	W4-W5		30	0		1
2,0	RC							I-II	W4-W5		37	0		2
3,0	RC							I-II	W4-W5		20	0		3
4,0	RC					4,00		IV	W2-W3		85	36		4
5,0	RC							IV	W2-W3		85	24		5
6,0	RC				Pink, moderately weathered-slightly weathered, moderate strong ANDESITE with rough and clean discontinuity surfaces. Three discontinuity sets were observed.			IV	W2-W3		91	68		6
7,0														
8,0	RC													
9,0								IV	W2-W3		51	0		7
10,0	RC							IV	W2-W3		59	12		8
11,0	RC													
12,0								IV	W2-W3		80	26		9
13,0	RC													
14,0														

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-3

SAYFA / Page 2 / 3

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+490	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+490	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 10.01.2008 -- 15.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Crallous D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength

I ÇOK DAYANIMLI	Strong
II DAYANIMLI	M.Strong
III ORTA	M.Weak
IV ZAYIF	Weak
V ÇOK ZAYIF	V.Weak

AYRIŞMA/Weathering

I TAZE	Fresh
II AZ AYRIŞMIŞ	Slighlly W.
III ORTA D. AYR.	Mod. Weath.
IV ÇOK AYR.	Highly W.
V TÜMÜYLE AYR.	Comp. W.

İNCE DANELİ/Fine Grained

N : 0-2	ÇOK YUMUŞAK	Very Soft
N : 3-4	YUMUŞAK	Soft
N : 5-8	ORTA KATI	Moderately Stiff
N : 9-15	KATI	Very Stiff
N :16-30	ÇOK KATI	Stiff
N : >30	SERT	Hard

İRİ DANELİ/Coarse Grained

N : 0-4	ÇOK GEVŞEK	Very Loose
N : 5-10	GEVŞEK	Loose
N : 11-30	ORTA SIKI	Moderately Dense
N : 31-50	SIKI	Dense
N : >50	ÇOK SIKI	Very Dense

KAYA KALİTESİ TANIMI/RQD

% 0-25 ÇOK ZAYIF	Very Poor
% 25-50 ZAYIF	Poor
% 50-75 ORTA	Fair
% 75-90 İYİ	Good
% 90-100 ÇOK İYİ	Excellent

KIRIKLAR-30 cm/Fractures

1	SEYREK	Wide (W)
1-2	ORTA	Moderate (M)
2-10	SIK	Close (Cl)
10-20	ÇOK SIKI	Intense (I)
>20	PARÇALI	Crushed (Cr)

ORANLAR/Proportions

% 5	PEK AZ	Slightly
% 5-15	AZ	Little
% 15-35	ÇOK	Very

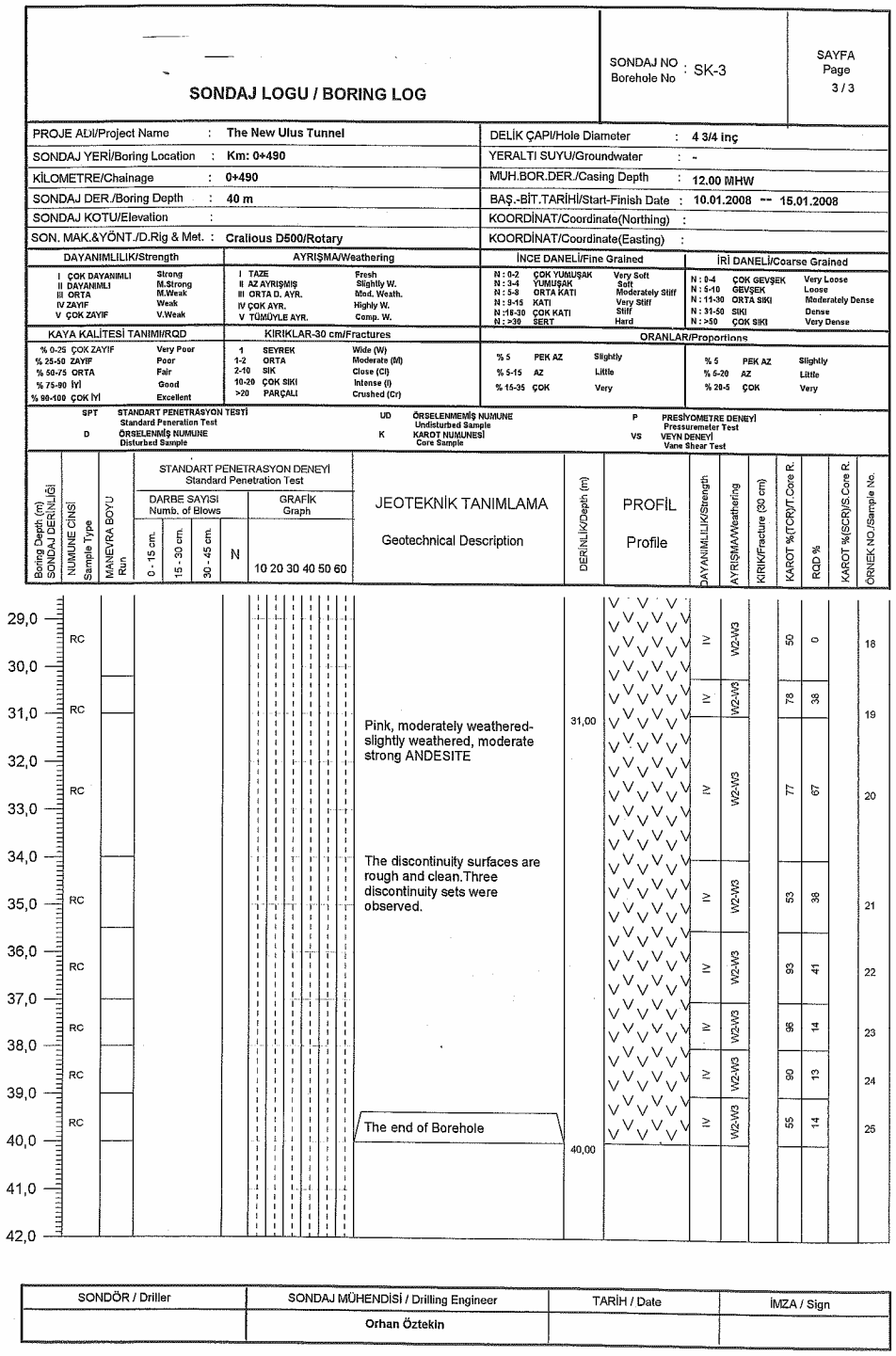
% 5	PEK AZ	Slightly
% 5-20	AZ	Little
% 20-5	ÇOK	Very

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
15,0	RC							Pink, moderately weathered-slightly weathered, moderate strong ANDESITE. Discontinuity surfaces are rough and clean. Three discontinuity sets at the angles of 30, 45 and 60 degrees are observed.			IV	W2-W3		61	12		10
16,0	RC										IV	W2-W3		88	41		11
17,0																	
18,0	RC										IV	W2-W3		83	32		12
19,0																	
20,0	RC										IV	W2-W3		64	22		13
21,0																	
22,0	RC										IV	W2-W3		73	0		14
23,0																	
24,0	RC										IV	W2-W3		69	13		15
25,0																	
26,0	RC										IV	W2-W3		37	0		16
27,0	RC							Pink, highly weathered, weak ANDESITE (Sand occurence was observed)	26,00		III	W4		50	0		17
28,0									28,40								

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued



SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-3

SAYFA / Page 3 / 3

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+490	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+490	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 10.01.2008 -- 15.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained			İRİ DANELİ/Coarse Grained		
I	ÇOK DAYANIMLI / Strong	I	TAZE / Fresh	N : 0-2	ÇOK YUMUŞAK / Very Soft		N : 0-4	ÇOK GEVŞEK / Very Loose	
II	DAYANIMLI / M.Strong	II	AZ AYRIŞMIŞ / Slightly W.	N : 3-4	YUMUŞAK / Soft		N : 5-10	GEVŞEK / Loose	
III	ORTA / M.Weak	III	ORTA D. AYR. / Mod. Weath.	N : 5-8	ORTA KATI / Moderately Stiff		N : 11-30	ORTA SIKI / Moderately Dense	
IV	ZAYIF / Weak	IV	ÇOK AYR. / Highly W.	N : 9-15	KATI / Very Stiff		N : 31-50	SIKI / Dense	
V	ÇOK ZAYIF / V.Weak	V	TÜMÜYLE AYR. / Comp. W.	N : 16-30	ÇOK KATI / Stiff		N : >50	ÇOK SIKI / Very Dense	
				N : >30	SERT / Hard				

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions					
% 0-25	ÇOK ZAYIF / Very Poor	1	SEYREK / Wide (W)	% 5	PEK AZ / Slightly		% 5	PEK AZ / Slightly	
% 25-50	ZAYIF / Poor	1-2	ORTA / Moderate (M)	% 5-15	AZ / Little		% 5-20	AZ / Little	
% 50-75	ORTA / Fair	2-10	SIK / Close (Cl)	% 15-35	ÇOK / Very		% 20-5	ÇOK / Very	
% 75-90	İYİ / Good	10-20	ÇOK SIKI / Intense (I)						
% 90-100	ÇOK İYİ / Excellent	>20	PARÇALI / Crushed (Cr)						

SPT	STANDART PENETRASYON TESTİ / Standard Peneration Test	UD	ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample	P	PRESİYOMETRE DENEYİ / Pressuremeter Test
D	ÖRSELENMİŞ NUMUNE / Disturbed Sample	K	KAROT NUMUNESİ / Core Sample	VS	VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows (0 - 15 cm., 15 - 30 cm., 30 - 45 cm.), N	GRAFİK / Graph (10 20 30 40 50 60)	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
29,0														
30,0	RC							IV	W2-W3		50	0		18
31,0	RC				Pink, moderately weathered-slightly weathered, moderate strong ANDESITE	31,00		IV	W2-W3		78	38		19
32,0	RC							IV	W2-W3		77	67		20
33,0														
34,0					The discontinuity surfaces are rough and clean.Three discontinuity sets were observed.									
35,0	RC							IV	W2-W3		53	38		21
36,0	RC							IV	W2-W3		93	41		22
37,0	RC							IV	W2-W3		98	14		23
38,0	RC							IV	W2-W3		90	13		24
39,0	RC							IV	W2-W3		55	14		25
40,0					The end of Borehole	40,00								
41,0														
42,0														

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK- 4

SAYFA / Page 1 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+755	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+755	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 100 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 10.01.2008 -- 21.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Crallous D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI — Strong II DAYANIMLI — M.Strong III ORTA — M.Weak IV ZAYIF — Weak V ÇOK ZAYIF — V.Weak	I TAZE — Fresh II AZ AYRIŞMIŞ — Slightly W. III ORTA D. AYR. — Mod. Weath. IV ÇOK AYR. — Highly W. V TÜMÜYLE AYR. — Comp. W.	N : 0-2 ÇOK YUMUŞAK — Very Soft N : 3-4 YUMUŞAK — Soft N : 5-8 ORTA KATI — Moderately Stiff N : 9-15 KATI — Very Stiff N :16-30 ÇOK KATI — Stiff N : >30 SERT — Hard	N : 0-4 ÇOK GEVŞEK — Very Loose N : 5-10 GEVŞEK — Loose N : 11-30 ORTA SIKI — Moderately Dense N : 31-50 SIKI — Dense N : >50 ÇOK SIKI — Very Dense

KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF — Very Poor % 25-50 ZAYIF — Poor % 50-75 ORTA — Fair % 75-90 İYİ — Good % 90-100 ÇOK İYİ — Excellent	1 SEYREK — Wide (W) 1-2 ORTA — Moderate (M) 2-10 SIK — Close (Cl) 10-20 ÇOK SIKI — Intense (I) >20 PARÇALI — Crushed (Cr)	% 5 PEK AZ — Slightly % 5-15 AZ — Little % 15-35 ÇOK — Very	% 5 PEK AZ — Slightly % 5-20 AZ — Little % 20-5 ÇOK — Very

SPT STANDART PENETRASYON TESTİ — Standard Penetration Test
D ÖRSELENMİŞ NUMUNE — Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE — Undisturbed Sample
K KAROT NUMUNESİ — Core Sample
P PRESİYOMETRE DENEYİ — Pressuremeter Test
VS VEYN DENEYİ — Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test — DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T. Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
0,0																	
1,0	RC							Pink-brown, completely weathered-highly weathered, weak-very weak ANDESITE.			I-II	W5-W4		21	0		1
2,0																	
3,0	RC							Sand occurance was observed.			I-II	W5-W4		21	0		2
4,0																	
5,0	RC										I-II	W5-W4		34	0		3
6,0																	
7,0																	
8,0	RC										I-II	W5-W4		19	0		4
9,0																	
10,0								Pink, moderately weathered-slightly weathered, moderate strong ANDESITE with cooling cracks.	9,50		"	W2-W3		20	14		5
11,0	RC							The discontinuity surfaces are rough and partly limonited. Three discontinuity sets at the angles of 30, 45 and 60 degrees are observed.									
12,0																	
13,0																	
14,0	RC										"	W2-W3		80	59		6

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-4

SAYFA / Page 2 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+755	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+755	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 100 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 10.01.2008 -- 21.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI Strong II DAYANIMLI M.Strong III ORTA M.Weak IV ZAYIF Weak V ÇOK ZAYIF V.Weak	I TAZE Fresh II AZ AYRIŞMIŞ Slightly W. III ORTA D. AYR. Mod. Weath. IV ÇOK AYR. Highly W. V TÜMÜYLE AYR. Comp. W.	N : 0-2 ÇOK YUMUŞAK Very Soft N : 3-4 YUMUŞAK Soft N : 5-8 ORTA KATI Moderately Stiff N : 9-15 KATI Very Stiff N :16-30 ÇOK KATI Stiff N : >30 SERT Hard	N : 0-4 ÇOK GEVŞEK Very Loose N : 5-10 GEVŞEK Loose N : 11-30 ORTA SIKI Moderately Dense N : 31-50 SIKI Dense N : >50 ÇOK SIKI Very Dense

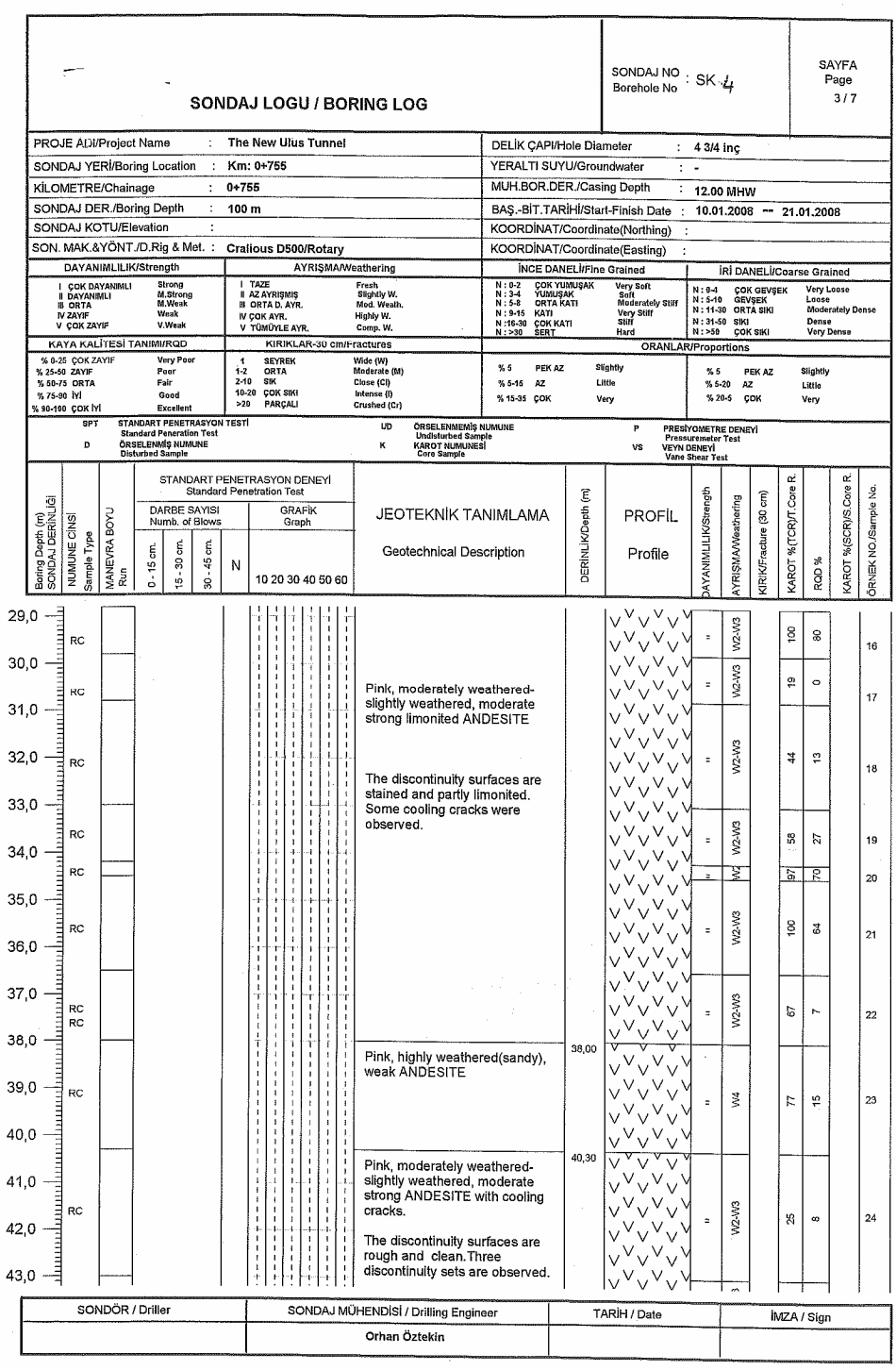
KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF Very Poor % 25-50 ZAYIF Poor % 50-75 ORTA Fair % 75-90 İYİ Good % 90-100 ÇOK İYİ Excellent	1 SEYREK Wide (W) 1-2 ORTA Moderate (M) 2-10 SIK Close (Cl) 10-20 ÇOK SIKI Intense (I) >20 PARÇALI Crushed (Cr)	% 5 PEK AZ Slightly % 5-15 AZ Little % 15-35 ÇOK Very	% 5 PEK AZ Slightly % 5-20 AZ Little % 20-5 ÇOK Very

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows (0 - 15 cm., 15 - 30 cm., 30 - 45 cm.)	N	GRAFİK / Graph (10 20 30 40 50 60)	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
15,0															
16,0	RC					Pink, moderately weathered-slightly weathered, moderate strong ANDESITE with cooling cracks.			=	W2-W3		56	52		7
17,0	RC					Between 17,40-17,70 m weak, decomposed; sandy material was observed.			=	W4		100	0		8
18,0	RC								=	W2-W3		67	25		9
19,0	RC								=	W2-W3		42	15		10
20,0	RC					The discontinuity surfaces are rough and clean.Three discontinuity sets at the angles of 30, 45 and 60 degrees are observed.			=	W2-W3		79	22		11
21,0	RC								=	W2-W3		71	41		12
22,0	RC								=	W2-W3		97	71		13
23,0	RC								=	W2-W3		100	54		14
24,0	RC								=	W2-W3		98	78		15
25,0	RC														
26,0															
27,0	RC														
28,0															

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued



SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-4

SAYFA / Page 3 / 7

PROJE ADI/Project Name	The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	4 3/4 inç
SONDAJ YERİ/Boring Location	Km: 0+755	YERALTI SUYU/Groundwater	-
KİLOMETRE/Chainage	0+755	MUH.BOR.DER./Casing Depth	12.00 MHW
SONDAJ DER./Boring Depth	100 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	10.01.2008 -- 21.01.2008
SONDAJ KOTU/Elevation		KOORDİNAT/Coordinate(Northing)	
SON. MAK.&YÖNT./D.Rig & Met.	Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI Strong	I TAZE Fresh	N : 0-2 ÇOK YUMUŞAK Very Soft	N : 0-4 ÇOK GEVŞEK Very Loose
II DAYANIMLI M.Strong	II AZ AYRIŞMIŞ Slighly W.	N : 3-4 YUMUŞAK Soft	N : 5-10 GEVŞEK Loose
III ORTA M.Weak	III ORTA D. AYR. Mod. Weath.	N : 5-8 ORTA KATI Moderately Stiff	N : 11-30 ORTA SIKI Moderately Dense
IV ZAYIF Weak	IV ÇOK AYR. Highly W.	N : 9-15 KATI Very Stiff	N : 31-50 SIKI Dense
V ÇOK ZAYIF V.Weak	V TÜMÜYLE AYR. Comp. W.	N :16-30 ÇOK KATI Stiff	N : >50 ÇOK SIKI Very Dense
		N : >30 SERT Hard	

KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF Very Poor	1 SEYREK Wide (W)	% 5 PEK AZ Slightly	% 5 PEK AZ Slightly
% 25-50 ZAYIF Poor	1-2 ORTA Moderate (M)	% 5-15 AZ Little	% 5-20 AZ Little
% 50-75 ORTA Fair	2-10 SIK Close (Cl)	% 15-35 ÇOK Very	% 20-5 ÇOK Very
% 75-90 İYİ Good	10-20 ÇOK SIKI Intense (I)		
% 90-100 ÇOK İYİ Excellent	>20 PARÇALI Crushed (Cr)		

SPT STANDART PENETRASYON TESTİ Standard Peneration Test
D ÖRSELENMİŞ NUMUNE Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE Undisturbed Sample
K KAROT NUMUNESİ Core Sample
P PRESİYOMETRE DENEYİ Pressuremeter Test
VS VEYN DENEYİ Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
29,0																	
30,0	RC																
31,0	RC																
32,0	RC																
33,0	RC																
34,0	RC																
35,0	RC																
36,0	RC																
37,0	RC																
38,0	RC							Pink, moderately weathered-slightly weathered, moderate strong limonited ANDESITE The discontinuity surfaces are stained and partly limonited. Some cooling cracks were observed.			=	W2-W3		100	80		16
39,0	RC										=	W2-W3		19	0		17
40,0	RC										=	W2-W3		44	13		18
41,0	RC										=	W2-W3		58	27		19
42,0	RC										=	W2		97	70		20
43,0											=	W2-W3		100	64		21
											=	W2-W3		67	7		22
								Pink, highly weathered(sandy), weak ANDESITE	38,00		=	W4		77	15		23
								Pink, moderately weathered-slightly weathered, moderate strong ANDESITE with cooling cracks. The discontinuity surfaces are rough and clean. Three discontinuity sets are observed.	40,30		=	W2-W3		25	8		24

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-4

SAYFA / Page 4 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+755	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+755	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 100 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 10.01.2008 -- 21.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI — Strong II DAYANIMLI — M.Strong III ORTA — M.Weak IV ZAYIF — Weak V ÇOK ZAYIF — V.Weak	I TAZE — Fresh II AZ AYRIŞMIŞ — Slightly W. III ORTA D. AYR. — Mod. Weath. IV ÇOK AYR. — Highly W. V TÜMÜYLE AYR. — Comp. W.	N : 0-2 ÇOK YUMUŞAK — Very Soft N : 3-4 YUMUŞAK — Soft N : 5-8 ORTA KATI — Moderately Stiff N : 9-15 KATI — Very Stiff N :16-30 ÇOK KATI — Stiff N : >30 SERT — Hard	N : 0-4 ÇOK GEVŞEK — Very Loose N : 5-10 GEVŞEK — Loose N : 11-30 ORTA SIKI — Moderately Dense N : 31-50 SIKI — Dense N : >50 ÇOK SIKI — Very Dense

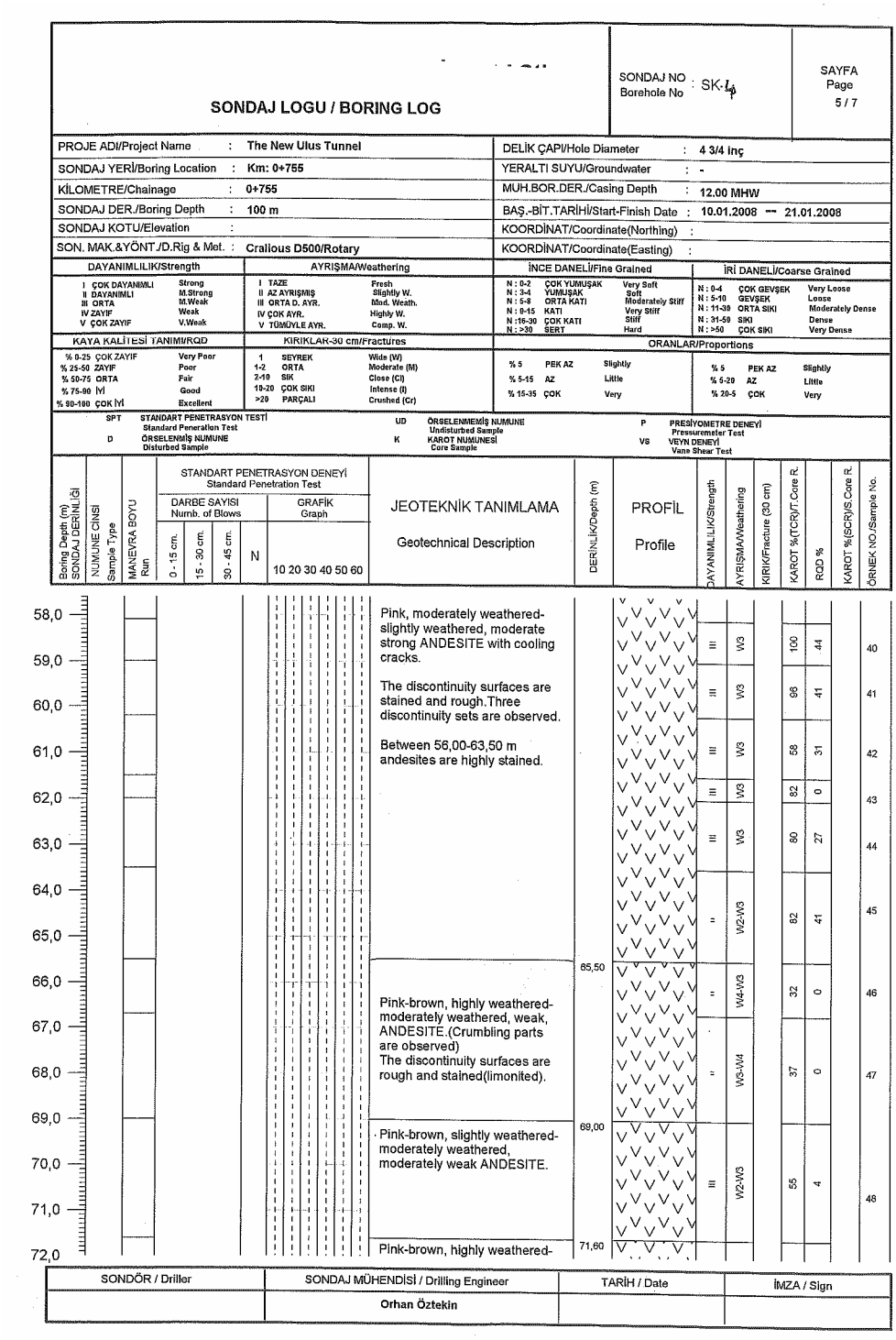
KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF — Very Poor % 25-50 ZAYIF — Poor % 50-75 ORTA — Fair % 75-90 İYİ — Good % 90-100 ÇOK İYİ — Excellent	1 SEYREK — Wide (W) 1-2 ORTA — Moderate (M) 2-10 SIK — Close (Cl) 10-20 ÇOK SIKI — Intense (I) >20 PARÇALI — Crushed (Cr)	% 5 PEK AZ — Slightly % 5-15 AZ — Little % 15-35 ÇOK — Very	% 5 PEK AZ — Slightly % 5-20 AZ — Little % 20-5 ÇOK — Very

SPT STANDART PENETRASYON TESTİ — Standard Penetration Test
D ÖRSELENMİŞ NUMUNE — Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE — Undisturbed Sample
K KAROT NUMUNESİ — Core Sample
P PRESİYOMETRE DENEYİ — Pressuremeter Test
VS VEYN DENEYİ — Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test — DARBE SAYISİ Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
44,0								Pink, moderately weathered-slightly weathered, moderate strong ANDESITE with cooling cracks. The discontinuity surfaces are rough and stained(limonited).Three discontinuity sets are observed.			II	W2-W3		72	13		25
45,0											II	W2-W3		95	42		26
46,0											II	W2-W3		68	32		27
47,0											II	W2-W3		81	37		28
48,0											II	W2-W3		92	0		29
49,0											II	W2-W3		28	0		30
50,0											II	W2-W3		60	12		31
51,0											II	W2-W3		51	0		32
52,0								Pink-brown, moderately weathered, weak-very weak,densely jointed ANDESITE.	51,00		III	W3		69	0		33
53,0											III	W3		84	0		34
54,0											III	W3		84	0		35
55,0											III	W3		100	0		36
56,0											III	W3		75	0		37
57,0											III	W3		65	15		38
									57,00		III	W3		44	15		39

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued



SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-4

SAYFA / Page 5 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+755	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+755	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 100 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 10.01.2008 -- 21.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Crallous D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained		İRİ DANELİ/Coarse Grained	
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2 ÇOK YUMUŞAK	Very Soft	N : 0-4 ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4 YUMUŞAK	Soft	N : 5-10 GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8 ORTA KATI	Moderately Stiff	N : 11-30 ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15 KATI	Very Stiff	N : 31-50 SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30 ÇOK KATI	Stiff	N : >50 ÇOK SIKI	Very Dense
				N : >30 SERT	Hard		

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions			
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5 PEK AZ	Slightly	% 5 PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15 AZ	Little	% 5-20 AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35 ÇOK	Very	% 20-5 ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)				
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)				

SPT STANDART PENETRASYON TESTİ / Standard Penetration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
58,0								Pink, moderately weathered-slightly weathered, moderate strong ANDESITE with cooling cracks. The discontinuity surfaces are stained and rough.Three discontinuity sets are observed. Between 56,00-63,50 m andesites are highly stained.			III	W3		100	44		
59,0																	40
60,0											III	W3		96	41		41
61,0											III	W3		58	31		42
62,0											III	W3		82	0		43
63,0											III	W3		80	27		44
64,0											II	W2-W3		82	41		45
65,0																	
66,0								Pink-brown, highly weathered-moderately weathered, weak, ANDESITE.(Crumbling parts are observed) The discontinuity surfaces are rough and stained(limonited).	65,50		II	W4-W3		32	0		46
67,0											II	W3-W4		37	0		47
68,0																	
69,0								Pink-brown, slightly weathered-moderately weathered, moderately weak ANDESITE.	69,00		III	W2-W3		55	4		48
70,0																	
71,0																	
72,0								Pink-brown, highly weathered-	71,60								

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-4

SAYFA / Page 6 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+755	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+755	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 100 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 10.01.2008 -- 21.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained		İRİ DANELİ/Coarse Grained	
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2 ÇOK YUMUŞAK	Very Soft	N : 0-4 ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Streng	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4 YUMUŞAK	Soft	N : 5-10 GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8 ORTA KATI	Moderately Stiff	N : 11-30 ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15 KATI	Very Stiff	N : 31-50 SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N : 16-30 ÇOK KATI	Stiff	N : >50 ÇOK SIKI	Very Dense
				N : >30 SERT	Hard		

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions			
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5 PEK AZ	Slightly	% 5 PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15 AZ	Little	% 5-20 AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35 ÇOK	Very	% 20-5 ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)				
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)				

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run.	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KİRİK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
72,0								moderately weathered, weak, crumbling ANDESITE. The discontinuity surfaces are rough and stained(limonited).			II	W2-W3		53	47		49
73,0																	
74,0									74,00		III	W2-W3		67	0		50
75,0								Pink-brown, slightly weathered-moderately weathered, moderately weak ANDESITE.									
76,0											III	W2-W3		100	30		51
77,0																	
78,0											III	W2-W3		46	70		52
79,0																	
80,0											III	W2-W3		71	21		53
81,0																	
82,0											III	W2-W3		53	55		54
83,0								Pink-brown, highly weathered, weak-moderately weak, limonitizated ANDESITE with perpendicular cooling cracks. The discontinuity surfaces are rough and stained(limonited).	82,50								
84,0											II	W3-W4		59	40		55
85,0																	
86,0								Pink-brown, slightly weathered-moderately weathered,	85,50		II	-W3		1	2		56

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-4

SAYFA / Page 7 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+755	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+755	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 100 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 10.01.2008 -- 21.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI — Strong II DAYANIMLI — M.Strong III ORTA — M.Weak IV ZAYIF — Weak V ÇOK ZAYIF — V.Weak	I TAZE — Fresh II AZ AYRIŞMIŞ — Slightly W. III ORTA D. AYR. — Mod. Weath. IV ÇOK AYR. — Highly W. V TÜMÜYLE AYR. — Comp. W.	N : 0-2 ÇOK YUMUŞAK — Very Soft N : 3-4 YUMUŞAK — Soft N : 5-8 ORTA KATI — Moderately Stiff N : 9-15 KATI — Very Stiff N :15-30 ÇOK KATI — Stiff N : >30 SERT — Hard	N : 0-4 ÇOK GEVŞEK — Very Loose N : 5-10 GEVŞEK — Loose N : 11-30 ORTA SIKI — Moderately Dense N : 31-50 SIKI — Dense N : >50 ÇOK SIKI — Very Dense

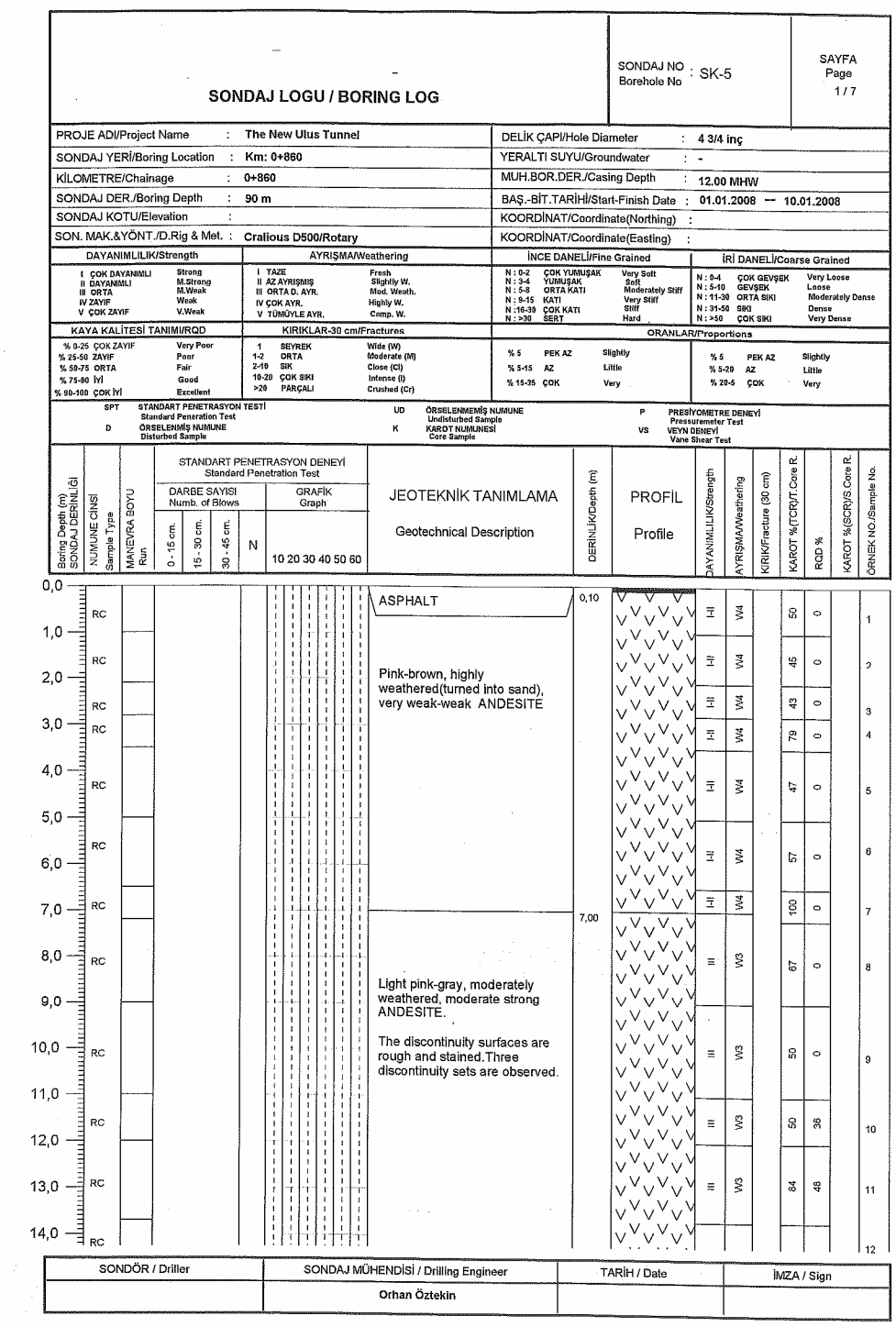
KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF — Very Poor % 25-50 ZAYIF — Poor % 50-75 ORTA — Fair % 75-90 İYİ — Good % 90-100 ÇOK İYİ — Excellent	1 SEYREK — Wide (W) 1-2 ORTA — Moderate (M) 2-10 SIK — Close (Cl) 10-20 ÇOK SIKI — Intense (I) >20 PARÇALI — Crushed (Cr)	% 5 PEK AZ — Slightly % 5-15 AZ — Little % 15-35 ÇOK — Very	% 5 PEK AZ — Slightly % 5-20 AZ — Little % 20-5 ÇOK — Very

SPT STANDART PENETRASYON TESTİ — Standard Penetration Test
D ÖRSELENMİŞ NUMUNE — Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE — Undisturbed Sample
K KAROT NUMUNESİ — Core Sample
P PRESİYOMETRE DENEYİ — Pressuremeter Test
VS VEYN DENEYİ — Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows (0 - 15 cm. / 15 - 30 cm. / 30 - 45 cm.)	N	GRAFİK / Graph (10 20 30 40 50 60)	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
87,0						moderate weak ANDESITE with rough discontinuity surfaces.	88,50		II	W2					
88,0									III	W2-W3		63	44		57
89,0									III	W2-W3					
90,0						Gray ,fresh, moderately strong ANDESITE with clean and rough discontinuity surfaces.			IV	W1		28	12		58
91,0									IV	W1					
92,0						Sandy, weak ANDESITE with cooling cracks.	92,30		V	W3		59	11		59
93,0						Gray ,fresh, moderately strong ANDESITE with clean and rough discontinuity surfaces.			IV	W1		72	38		60
94,0															
95,0									IV	W1		28	4		61
96,0															
97,0									IV	W1		100	68		62
98,0															
99,0									IV	W1		100	83		63
100,0						End of the borehole									

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued



SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-5

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PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+860	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+860	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 90 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 01.01.2008 -- 10.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength: I ÇOK DAYANIMLI Strong; II DAYANIMLI M.Strong; III ORTA M.Weak; IV ZAYIF Weak; V ÇOK ZAYIF V.Weak

AYRIŞMA/Weathering: I TAZE Fresh; II AZ AYRIŞMIŞ Slightly W.; III ORTA D. AYR. Mod. Weath.; IV ÇOK AYR. Highly W.; V TÜMÜYLE AYR. Comp. W.

İNCE DANELİ/Fine Grained: N : 0-2 ÇOK YUMUŞAK Very Soft; N : 3-4 YUMUŞAK Soft; N : 5-8 ORTA KATI Moderately Stiff; N : 9-15 KATI Very Stiff; N :16-30 ÇOK KATI Stiff; N : >30 SERT Hard

İRİ DANELİ/Coarse Grained: N : 0-4 ÇOK GEVŞEK Very Loose; N : 5-10 GEVŞEK Loose; N : 11-30 ORTA SIKI Moderately Dense; N : 31-50 SIKI Dense; N : >50 ÇOK SIKI Very Dense

KAYA KALİTESİ TANIMI/RQD: % 0-25 ÇOK ZAYIF Very Poor; % 25-50 ZAYIF Poor; % 50-75 ORTA Fair; % 75-90 İYİ Good; % 90-100 ÇOK İYİ Excellent

KIRIKLAR-30 cm/Fractures: 1 SEYREK Wide (W); 1-2 ORTA Moderate (M); 2-10 SIK Close (Cl); 10-20 ÇOK SIKI Intense (I); >20 PARÇALI Crushed (Cr)

ORANLAR/Proportions: % 5 PEK AZ Slightly; % 5-15 AZ Little; % 15-35 ÇOK Very

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
0,0	RC							ASPHALT	0,10		I-II	W4		50	0		1
1,0	RC							Pink-brown, highly weathered(turned into sand), very weak-weak ANDESITE			I-II	W4		45	0		2
2,0	RC										I-II	W4		43	0		3
3,0	RC										I-II	W4		79	0		4
4,0	RC										I-II	W4		47	0		5
5,0	RC										I-II	W4		57	0		6
6,0	RC										I-II	W4		100	0		7
7,0	RC								7,00		III	W3		67	0		8
8,0	RC							Light pink-gray, moderately weathered, moderate strong ANDESITE.			III	W3		50	0		9
9,0	RC							The discontinuity surfaces are rough and stained.Three discontinuity sets are observed.			III	W3		50	36		10
10,0	RC										III	W3		84	48		11
11,0	RC																12
12,0	RC																
13,0	RC																
14,0	RC																

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-5

SAYFA / Page 2 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+860	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+860	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 90 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 01.01.2008 -- 10.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained		İRİ DANELİ/Coarse Grained	
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2 ÇOK YUMUŞAK	Very Soft	N : 0-4 ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slighly W.	N : 3-4 YUMUŞAK	Soft	N : 5-10 GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8 ORTA KATI	Moderately Stiff	N : 11-30 ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15 KATI	Very Stiff	N : 31-50 SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30 ÇOK KATI	Stiff	N : >50 ÇOK SIKI	Very Dense
				N : >30 SERT	Hard		

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions			
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5 PEK AZ	Slightly	% 5 PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15 AZ	Little	% 5-20 AZ	Little
% 50-75 ORTA	Fair	2-19 SIK	Close (Cl)	% 15-35 ÇOK	Very	% 20-5 ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)				
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)				

SPT	STANDART PENETRASYON TESTİ Standard Peneration Test	UD	ÖRSELENMEMİŞ NUMUNE Undisturbed Sample	P	PRESİYOMETRE DENEYİ Pressuremeter Test
D	ÖRSELENMİŞ NUMUNE Disturbed Sample	K	KAROT NUMUNESİ Core Sample	VS	VEYN DENEYİ Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
15,0																	
16,0	KC										III	W3		87	54		13
17,0											III	W3		84	42		
18,0	RC										III	W3		93	23		14
19,0											III	W3					
20,0	RC							Light pink-gray, moderately weathered, moderate strong ANDESITE.			III	W3		100	64		15
21,0	RC							The discontinuity surfaces are rough and stained.Three discontinuity sets are observed.			III	W3		100	68		16
22,0	RC										III	W3		98	91		17
23,0											III	W3					
24,0	RC										III	W3		100	67		18
25,0	RC										III	W3		100	82		19
26,0	RC										III	W3		100	48		20
27,0											III	W3		59	18		21
28,0	RC																

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-5

SAYFA / Page 3 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+860	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+860	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 90 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 01.01.2008 -- 10.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Crallous D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained			İRİ DANELİ/Coarse Grained		
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2	ÇOK YUMUŞAK	Very Soft	N : 0-4	ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4	YUMUŞAK	Soft	N : 5-10	GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8	ORTA KATI	Moderately Stiff	N : 11-30	ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15	KATI	Very Stiff	N : 31-50	SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30	ÇOK KATI	Stiff	N : >50	ÇOK SIKI	Very Dense
				N : >30	SERT	Hard			

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions					
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)						
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)						

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T. Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
29,0																	
30,0	RC										III	W3		77	58		22
31,0	RC										III	W3		100	79		23
32,0	RC										III	W3		99	91		24
33,0	RC										III	W3		94	94		25
34,0	RC										III	W3		100	100		26
35,0	RC							Light pink-gray, moderately weathered, moderate strong ANDESITE.			III	W3		100	55		27
36,0	RC							The discontinuity surfaces are rough and stained.Three discontinuity sets are observed.			III	W3		100	68		28
37,0	RC										III	W3		85	33		29
38,0	RC										III	W3		100	56		30
39,0	RC										III	W3		80	47		31
40,0	RC										III	W3		62	23		32
41,0	RC																
42,0	RC																

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-5

SAYFA / Page 4 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+860	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+860	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 90 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 01.01.2008 -- 10.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained		İRİ DANELİ/Coarse Grained	
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2 ÇOK YUMUŞAK	Very Soft	N : 0-4 ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4 YUMUŞAK	Soft	N : 5-10 GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8 ORTA KATI	Moderately Stiff	N : 11-30 ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15 KATI	Very Stiff	N : 31-50 SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30 ÇOK KATI	Stiff	N : >50 ÇOK SIKI	Very Dense
				N : >30 SERT	Hard		

KAYA KALİTESİ TANIMI/RQD		KİRİKLAR-30 cm/Fractures		ORANLAR/Proportions					
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)						
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)						

SPT STANDART PENETRASYON TESTİ / Standard Penetration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KİRİK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
43,0	RC							Light pink-gray, moderately weathered, moderate strong ANDESITE.			III	W3		25	0		33
44,0	RC										III	W3		67	0		34
45,0	RC										III	W3		50	18		35
46,0	RC										III	W3		62	29		36
47,0	RC										III	W3		100	61		37
48,0								The discontinuity surfaces are rough and stained.Three discontinuity sets are observed.			III	W3		95	87		38
49,0	RC										III	W3		90	0		39
50,0	RC										III	W3		95	82		40
51,0	RC																
52,0											III	W3		100	91		41
53,0	RC																
54,0																	
55,0											III	W3		100	83		42
56,0	RC																
57,0																	

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-5

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PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+860	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+860	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 90 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 01.01.2008 --- 10.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI Strong	I TAZE Fresh	N : 0-2 ÇOK YUMUŞAK Very Soft	N : 0-4 ÇOK GEVŞEK Very Loose
II DAYANIMLI M.Strong	II AZ AYRIŞMIŞ Slightly W.	N : 3-4 YUMUŞAK Soft	N : 5-10 GEVŞEK Loose
III ORTA M.Weak	III ORTA D. AYR. Mod. Weath.	N : 5-8 ORTA KATI Moderately Stiff	N : 11-30 ORTA SIKI Moderately Dense
IV ZAYIF Weak	IV ÇOK AYR. Highly W.	N : 9-15 KATI Very Stiff	N : 31-50 SIKI Dense
V ÇOK ZAYIF V.Weak	V TÜMÜYLE AYR. Comp. W.	N : 16-30 ÇOK KATI Stiff	N : >50 ÇOK SIKI Very Dense
		N : >30 SERT Hard	

KAYA KALİTESİ TANIMI/ROD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF Very Poor	1 SEYREK Wide (W)	% 5 PEK AZ Slighly	% 5 PEK AZ Slightly
% 25-50 ZAYIF Poor	1-2 ORTA Moderate (MI)	% 5-15 AZ Little	% 5-20 AZ Little
% 50-75 ORTA Fair	2-10 SIK Close (CI)	% 15-35 ÇOK Very	% 20-5 ÇOK Very
% 75-90 İYİ Good	10-20 ÇOK SIKI Intense (I)		
% 90-100 ÇOK İYİ Excellent	>20 PARÇALI Crushed (Cr)		

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows (0 - 15 cm. / 15 - 30 cm. / 30 - 45 cm.)	N	GRAFİK / Graph (10 20 30 40 50 60)	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
57,0															
58,0	RC					Light pink-gray, moderately weathered, moderate strong ANDESITE.			III	W3		77	75		43
59,0	RC					The discontinuity surfaces are rough and stained.Three discontinuity sets are observed.			III	W3		100	100		44
60,0	RC								III	W3		86	65		45
61,0	RC								III	W3		60	48		46
62,0	RC								III	W3		70	24		47
63,0	RC						63,50								
64,0	RC					Light pink-gray, highly weathered, very weak ANDESITE			I	W4		0	0		48
65,0	RC								I	W4		7	0		49
66,0	RC								I	W4		57	0		50
67,0	RC														
68,0	RC						68,50								
69,0	RC					Light pink, moderately weathered, moderate weak ANDESITE.			III	W3		80	69		51
70,0	RC														
71,0							71,00								

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-5

SAYFA / Page 6 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+860	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+860	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 90 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 01.01.2008 -- 10.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI Strong	I TAZE Fresh	N : 0-2 ÇOK YUMUŞAK Very Soft	N : 0-4 ÇOK GEVŞEK Very Loose
II DAYANIMLI M.Strong	II AZ AYRIŞMIŞ Slightly W.	N : 3-4 YUMUŞAK Soft	N : 5-10 GEVŞEK Loose
III ORTA M.Weak	III ORTA D. AYR. Mod. Weath.	N : 5-8 ORTA KATI Moderately Stiff	N : 11-30 ORTA SIKI Moderately Dense
IV ZAYIF Weak	IV ÇOK AYR. Highly W.	N : 9-15 KATI Very Stiff	N : 31-50 SIKI Dense
V ÇOK ZAYIF V.Weak	V TÜMÜYLE AYR. Comp. W.	N :16-30 ÇOK KATI Stiff	N : >50 ÇOK SIKI Very Dense
		N : >30 SERT Hard	

KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF Very Poor	1 SEYREK Wide (W)	% 5 PEK AZ Slightly	% 5 PEK AZ Slightly
% 25-50 ZAYIF Poor	1-2 ORTA Moderate (M)	% 5-15 AZ Little	% 5-20 AZ Little
% 50-75 ORTA Fair	2-10 SIK Close (Cl)	% 15-35 ÇOK Very	% 20-5 ÇOK Very
% 75-90 İYİ Good	10-20 ÇOK SIKI Intense (I)		
% 90-100 ÇOK İYİ Excellent	>20 PARÇALI Crushed (Cr)		

SPT STANDART PENETRASYON TESTİ / Standard Penetration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
72,0	RC							Pink-brown, highly weathered (partly sandy), weak ANDESITE .			I	W4		24	4		52
73,0																	
74,0																	
75,0	RC								75,00								
76,0								Light pink, moderately weathered,moderately weak ANDESITE			III	W3		47	17		53
77,0																	
78,0	RC							Light pink, highly weathered (sand occurance), very weak ANDESITE	77,80		I	W5		100	32		54
79,0	RC								78,80		I	W5		100	0		55
80,0	RC										III	W3		57	39		56
81,0	RC							Pink-brown, moderately weathered, moderate weak ANDESITE .			III	W3		32	20		57
82,0																	
83,0	RC										III	W3		16	6		58
84,0																	
85,0	RC										III	W3		47	19		59

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-5

SAYFA / Page 7 / 7

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+860	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+860	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 90 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 01.01.2008 -- 10.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained			İRİ DANELİ/Coarse Grained		
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2	ÇOK YUMUŞAK	Very Soft	N : 0-4	ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4	YUMUŞAK	Soft	N : 5-10	GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8	ORTA KATI	Moderately Stiff	N : 11-30	ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15	KATI	Very Stiff	N : 31-50	SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30	ÇOK KATI	Stiff	N : >50	ÇOK SIKI	Very Dense
				N : >30	SERT	Hard			

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions					
% 0-25	ÇOK ZAYIF	Very Poor	1	SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50	ZAYIF	Poor	1-2	ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75	ORTA	Fair	2-10	SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90	İYİ	Good	10-20	ÇOK SIKI	Intense (I)						
% 90-100	ÇOK İYİ	Excellent	>20	PARÇALI	Crushed (Cr)						

SPT	STANDART PENETRASYON TESTİ Standard Penetration Test	UD	ÖRSELENMEMİŞ NUMUNE Undisturbed Sample	P	PRESİYOMETRE DENEYİ Pressuremeter Test
D	ÖRSELENMİŞ NUMUNE Disturbed Sample	K	KAROT NUMUNESİ Core Sample	VS	VEYN DENEYİ Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
86,0																	
87,0	RC							Pink-brown, moderately weathered, moderate weak ANDESITE			III	W3		40	20		60
88,0																	
89,0	RC										III	W3		23	6		61
90,0								End of the Borehole	90,00								
91,0																	
92,0																	
93,0																	
94,0																	
95,0																	
96,0																	
97,0																	
98,0																	
99,0																	

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-6

SAYFA / Page 1 / 4

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+895	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+895	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 50 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 22.01.2008 --- 26.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained		İRİ DANELİ/Coarse Grained	
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2 ÇOK YUMUŞAK	Very Soft	N : 0-4 ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4 YUMUŞAK	Soft	N : 5-10 GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8 ORTA KATI	Moderately Stiff	N : 11-30 ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15 KATI	Very Stiff	N : 31-50 SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30 ÇOK KATI	Stiff	N : >50 ÇOK SIKI	Very Dense
				N : >30 SERT	Hard		

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions			
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5 PEK AZ	Slightly	% 5 PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15 AZ	Little	% 5-20 AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35 ÇOK	Very	% 20-5 ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)				
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)				

SPT STANDART PENETRASYON TESTİ / Standard Penetration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
0,0																	
1,0	RC							ASPHALT	0,60		I-III	W3-W4		23	8		1
2,0								Pink-brown, moderately weathered-highly weathered, very weak -weak ANDESITE									
3,0	RC										I-III	W3-W4		24	0		2
4,0									3,50								
5,0	RC							Pink-brown, slightly weathered-moderately weathered, moderate strong, jointed ANDESITE.			III	W2-W3		14	0		3
6,0								The discontinuity surfaces are limonited and rough. Perpendicular cracks are observed at the depths between 3,50-15,50 m									
7,0											III	W2-W3		24	6		4
8,0	RC																
9,0																	
10,0											III	W2-W3		32	0		5
11,0	RC																
12,0											III	W2-W3		80	11		6
13,0	RC																
14,0	RC										III	W2-W3		100	15		7

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-6

SAYFA / Page 2 / 4

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+895	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+895	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 50 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 22.01.2008 -- 26.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained		İRİ DANELİ/Coarse Grained	
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2 ÇOK YUMUŞAK	Very Soft	N : 0-4 ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4 YUMUŞAK	Soft	N : 5-10 GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8 ORTA KATI	Moderately Stiff	N : 11-30 ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15 KATI	Very Stiff	N : 31-50 SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N : 16-30 ÇOK KATI	Stiff	N : >50 ÇOK SIKI	Very Dense
				N : >30 SERT	Hard		

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions					
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)						
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)						

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) SONDAJ DERİNLİĞİ	NUMUNE CİNSİ Sample Type	MANEVRA BOYU Run	STANDART PENETRASYON DENEYİ Standard Penetration Test: DARBE SAYISI Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA Geotechnical Description	DERİNLİK/Depth (m)	PROFİL Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
15,0	RC							Pink-brown, slightly weathered-moderately weathered, moderate strong, jointed ANDESITE. The discontinuity surfaces are limonited and rough			III	W2-W3		96	42		8
16,0	RC										III	W2-W3		100	77		9
17,0	RC										III	W2-W3		99	65		10
18,0																	
19,0	RC										III	W2-W3		46	20		11
20,0																	
21,0	RC										III	W2-W3		34	12		12
22,0	RC										III	W2-W3		47	47		13
23,0																	
24,0																	
25,0	RC										III	W2-W3		67	50		14
26,0																	
27,0	RC							Pink-brown, slightly weathered-moderate weathered, moderate weak ANDESITE. The discontinuity surfaces are rough and stained.	26,40		–	W3-W4		24	0		15
28,0																	

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-6

SAYFA / Page 3 / 4

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+895	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+895	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 50 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 22.01.2008 -- 26.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength

I ÇOK DAYANIMLI	Strong
II DAYANIMLI	M.Strong
III ORTA	M.Weak
IV ZAYIF	Weak
V ÇOK ZAYIF	V.Weak

AYRIŞMA/Weathering

I TAZE	Fresh
II AZ AYRIŞMIŞ	Slightly W.
III ORTA D. AYR.	Mod. Weath.
IV ÇOK AYR.	Highly W.
V TÜMÜYLE AYR.	Comp. W.

İNCE DANELİ/Fine Grained

N : 0-2	ÇOK YUMUŞAK	Very Soft
N : 3-4	YUMUŞAK	Soft
N : 5-8	ORTA KATI	Moderately Stiff
N : 9-15	KATI	Very Stiff
N :16-30	ÇOK KATI	Stiff
N : >30	SERT	Hard

İRİ DANELİ/Coarse Grained

N : 0-4	ÇOK GEVŞEK	Very Loose
N : 5-10	GEVŞEK	Loose
N : 11-30	ORTA SIKI	Moderately Dense
N : 31-50	SIKI	Dense
N : >50	ÇOK SIKI	Very Dense

KAYA KALİTESİ TANIMI/RQD

% 0-25 ÇOK ZAYIF	Very Poor
% 25-50 ZAYIF	Poor
% 50-75 ORTA	Fair
% 75-90 İYİ	Good
% 90-100 ÇOK İYİ	Excellent

KIRIKLAR-30 cm/Fractures

1	SEYREK	Wide (W)
1-2	ORTA	Moderate (M)
2-10	SIK	Close (Cl)
10-20	ÇOK SIKI	Intense (I)
>20	PARÇALI	Crushed (Cr)

ORANLAR/Proportions

% 5	PEK AZ	Slightly
% 5-15	AZ	Little
% 15-35	ÇOK	Very

% 5	PEK AZ	Slightly
% 5-20	AZ	Little
% 20-5	ÇOK	Very

SPT	STANDART PENETRASYON TESTİ / Standard Peneration Test	U/D	ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
D	ÖRSELENMİŞ NUMUNE / Disturbed Sample	K	KAROT NUMUNESİ / Core Sample
P	PRESİYOMETRE DENEYİ / Pressuremeter Test	VS	VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
29,0																	
30,0	RC							Pink-brown, slightly weathered-moderate weathered, moderate weak ANDESITE The discontinuity surfaces are rough and stained.			I	W3-W4		33	0		16
31,0	RC										III	W2-W3		67	50		17
32,0									32,40								
33,0	RC							Pink-brown, moderately weathered, very weak ANDESITE.The specimens are crumbling into sand size particles. The core surfaces are limonited. (Between 35,20-35,50 m slighly weathered and very weak andesite is observed)			I	W3-W4		40	0		18
34,0	RC										I	W3-W4		71	0		19
35,0											III	W2					
36,0	RC										I	W3-W4		75	32		20
37,0									37,00								
38,0	RC							Pink, slightly weathered ,moderate strong ANDESITE.			III	W2		100	61		21
39,0	RC								38,60								
40,0								Pink-brown, moderately weathered, very weak ANDESITE. The core surfaces and siscontinuity surfaces are stained(limonitied)			I	W3-W4		71	0		22
41,0																	
42,0	RC							Pink-brown, moderately weathered, very weak ANDESITE.			I	W3-W4		33	15		23

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-6

SAYFA / Page 4 / 4

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+895	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+895	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 50 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 22.01.2008 -- 26.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI — Strong II DAYANIMLI — M.Strong III ORTA — M.Weak IV ZAYIF — Weak V ÇOK ZAYIF — V.Weak	I TAZE — Fresh II AZ AYRIŞMIŞ — Slightly W. III ORTA D. AYR. — Mod. Weath. IV ÇOK AYR. — Highly W. V TÜMÜYLE AYR. — Comp. W.	N : 0-2 ÇOK YUMUŞAK — Very Soft N : 3-4 YUMUŞAK — Soft N : 5-8 ORTA KATI — Moderately Stiff N : 9-15 KATI — Very Stiff N :16-30 ÇOK KATI — Stiff N : >30 SERT — Hard	N : 0-4 ÇOK GEVŞEK — Very Loose N : 5-10 GEVŞEK — Loose N : 11-30 ORTA SIKI — Moderately Dense N : 31-50 SIKI — Dense N : >50 ÇOK SIKI — Very Dense

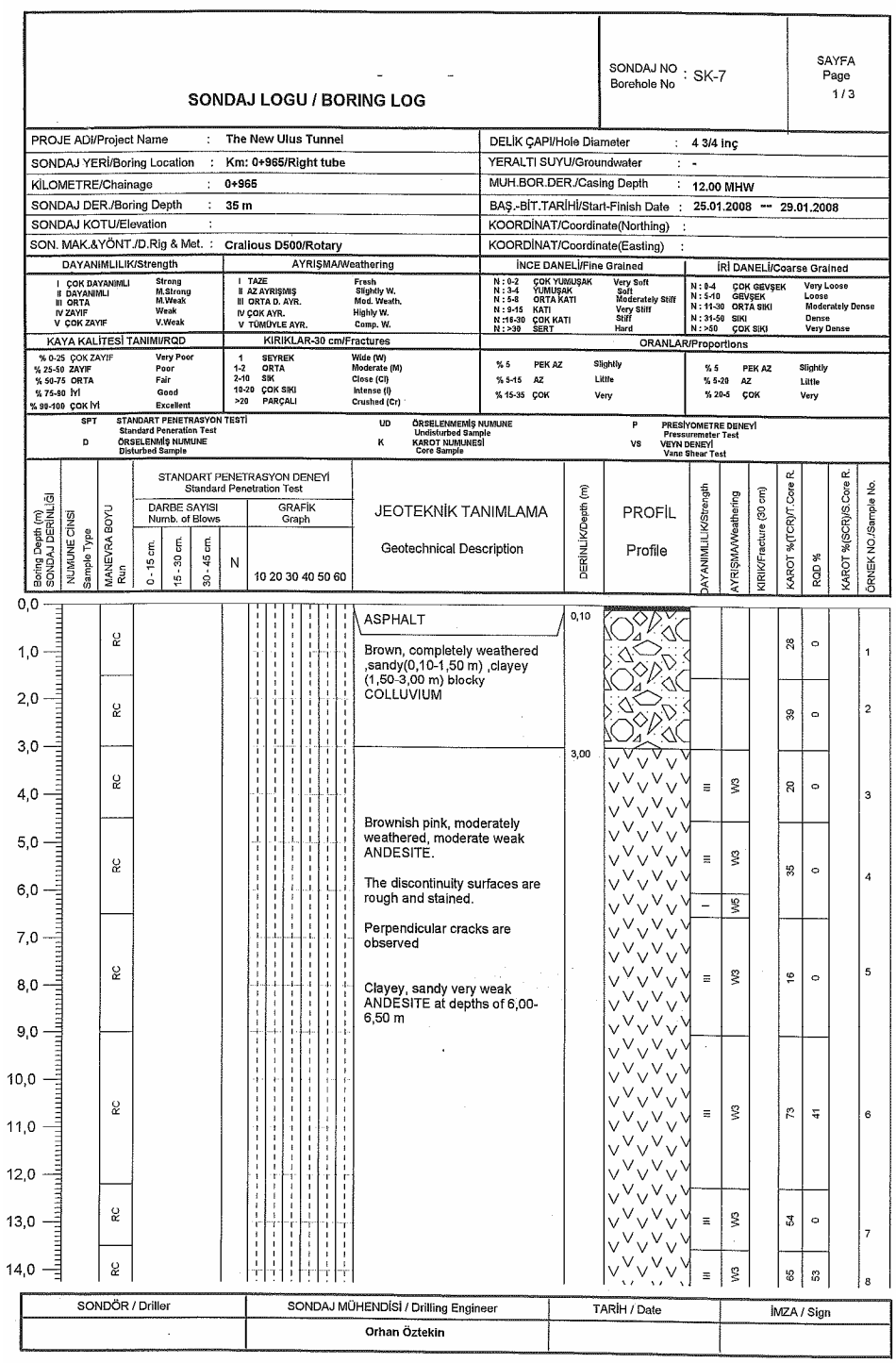
KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF — Very Poor % 25-50 ZAYIF — Poor % 50-75 ORTA — Fair % 75-90 İYİ — Good % 90-100 ÇOK İYİ — Excellent	1 SEYREK — Wide (W) 1-2 ORTA — Moderate (M) 2-10 SIK — Close (Cl) 10-20 ÇOK SIKI — Intense (I) >20 PARÇALI — Crushed (Cr)	% 5 PEK AZ — Slightly % 5-15 AZ — Little % 15-35 ÇOK — Very	% 5 PEK AZ — Slightly % 5-20 AZ — Little % 20-5 ÇOK — Very

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test — DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
43,0								The core surfaces and siscontinuity surfaces are stained(limonitied)			I	W3-W4		41	0		24
44,0	RC																
45,0	RC							Pink, slightly weathered ,moderate strong ANDESITE.	45,00		III	W2		69	33		25
46,0																	
47,0	RC							Pink, moderately weathered,weak ANDESITE	46,30		I	W3-W4		79	41		26
48,0								Pink, slightly weathered, moderate strong ANDESITE	47,30		III	W2					
49,0	RC							Pink-brown, sligthly weathered, moderately strong ANDESITE.The joints surfaces are rough, partly stained.	48,50		III	W2		83	72		27
50,0								The end of borehole	50,00								
51,0																	
52,0																	
53,0																	
54,0																	
55,0																	
56,0																	
57,0																	

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued



SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-7

SAYFA / Page 1 / 3

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+965/Right tube	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+965	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 35 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 25.01.2008 --- 29.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained			İRİ DANELİ/Coarse Grained		
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2	ÇOK YUMUŞAK	Very Soft	N : 0-4	ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4	YUMUŞAK	Soft	N : 5-10	GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8	ORTA KATI	Moderately Stiff	N : 11-30	ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15	KATI	Very Stiff	N : 31-50	SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30	ÇOK KATI	Stiff	N : >50	ÇOK SIKI	Very Dense
				N : >30	SERT	Hard			

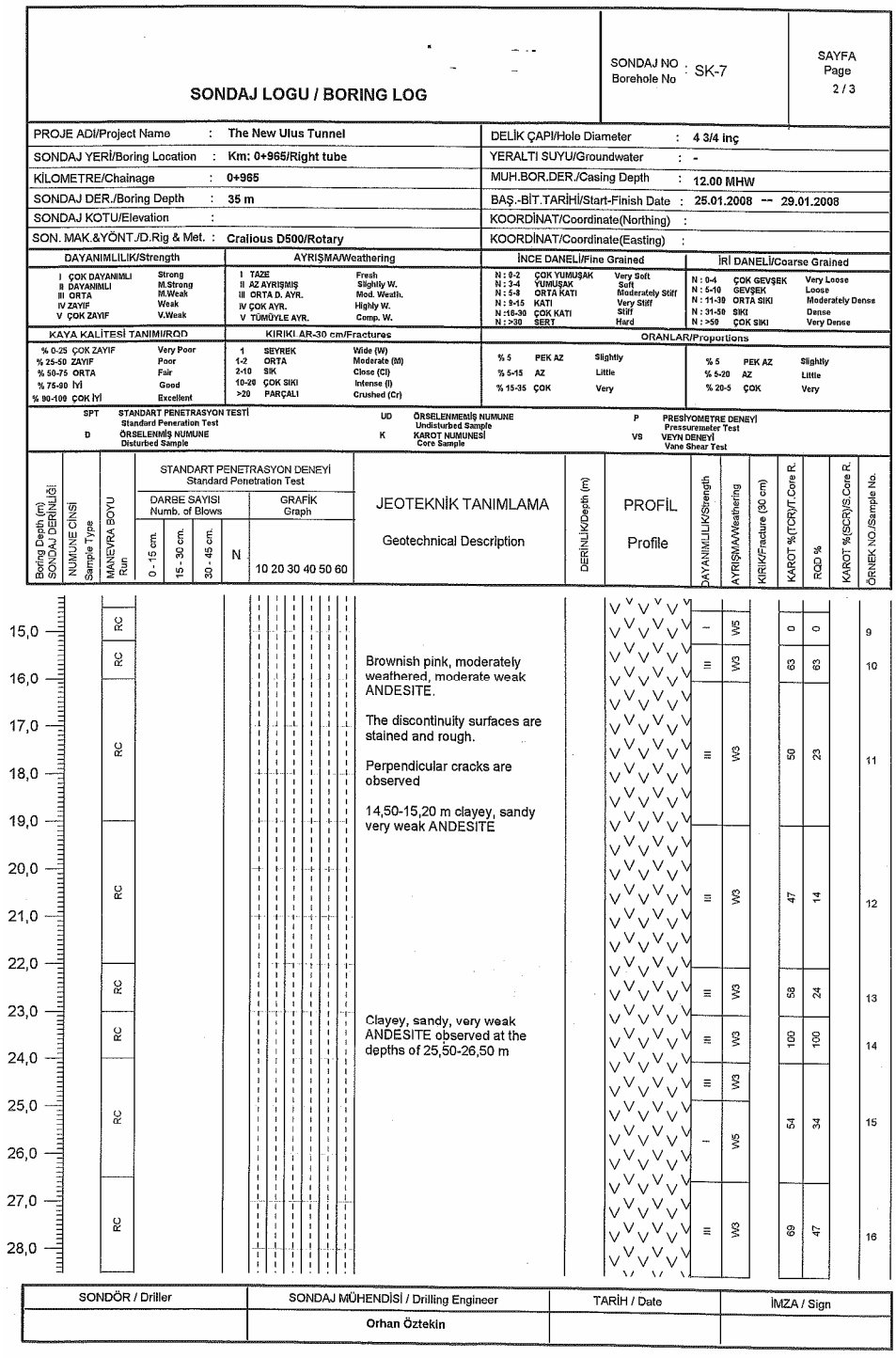
KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions					
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)						
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)						

SPT STANDART PENETRASYON TESTİ / Standard Penetration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYNİ DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
0,0								ASPHALT	0,10								
1,0	RC							Brown, completely weathered ,sandy(0,10-1,50 m) ,clayey (1,50-3,00 m) blocky COLLUVIUM						28	0		1
2,0	RC													39	0		2
3,0	RC								3,00		III	W3		20	0		3
4,0	RC							Brownish pink, moderately weathered, moderate weak ANDESITE.			III	W3		35	0		4
5,0	RC							The discontinuity surfaces are rough and stained.			–	W5					
6,0	RC							Perpendicular cracks are observed			III	W3		16	0		5
7,0	RC																
8,0	RC							Clayey, sandy very weak ANDESITE at depths of 6,00-6,50 m			III	W3		73	41		6
9,0	RC																
10,0	RC																
11,0	RC																
12,0	RC																
13,0	RC										III	W3		54	0		7
14,0	RC										III	W3		65	53		8

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued



SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-7

SAYFA / Page 2 / 3

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+965/Right tube	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+965	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 35 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 25.01.2008 -- 29.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength	AYRIŞMA/Weathering	İNCE DANELİ/Fine Grained	İRİ DANELİ/Coarse Grained
I ÇOK DAYANIMLI Strong	I TAZE Fresh	N : 0-2 ÇOK YUMUŞAK Very Soft	N : 0-4 ÇOK GEVŞEK Very Loose
II DAYANIMLI M.Strong	II AZ AYRIŞMIŞ Slightly W.	N : 3-4 YUMUŞAK Soft	N : 5-10 GEVŞEK Loose
III ORTA M.Weak	III ORTA D. AYR. Mod. Weath.	N : 5-8 ORTA KATI Moderately Stiff	N : 11-30 ORTA SIKI Moderately Dense
IV ZAYIF Weak	IV ÇOK AYR. Highly W.	N :9-15 KATI Very Stiff	N : 31-50 SIKI Dense
V ÇOK ZAYIF V.Weak	V TÜMÜYLE AYR. Comp. W.	N :16-30 ÇOK KATI Stiff	N : >50 ÇOK SIKI Very Dense
		N : >30 SERT Hard	

KAYA KALİTESİ TANIMI/RQD	KIRIKLAR-30 cm/Fractures	ORANLAR/Proportions	
% 0-25 ÇOK ZAYIF Very Poor	1 SEYREK Wide (W)	% 5 PEK AZ Slightly	% 5 PEK AZ Slightly
% 25-50 ZAYIF Poor	1-2 ORTA Moderate (M)	% 5-15 AZ Little	% 5-20 AZ Little
% 50-75 ORTA Fair	2-10 SIK Close (Cl)	% 15-35 ÇOK Very	% 20-5 ÇOK Very
% 75-90 İYİ Good	10-20 ÇOK SIKI Intense (I)		
% 90-100 ÇOK İYİ Excellent	>20 PARÇALI Crushed (Cr)		

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
15,0	RC							Brownish pink, moderately weathered, moderate weak ANDESITE.			I	W5	0	0			9
16,0	RC							The discontinuity surfaces are stained and rough.			III	W3	63	63			10
17,0	RC							Perpendicular cracks are observed			III	W3	50	23			11
18,0																	
19,0								14,50-15,20 m clayey, sandy very weak ANDESITE									
20,0	RC										III	W3	47	14			12
21,0																	
22,0	RC										III	W3	58	24			13
23,0	RC							Clayey, sandy, very weak ANDESITE observed at the depths of 25,50-26,50 m			III	W3	100	100			14
24,0											III	W3					
25,0	RC										I	W5	54	34			15
26,0																	
27,0	RC										III	W3	69	47			16
28,0																	

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-7

SAYFA / Page 3 / 3

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+965/Right tube	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+965	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 35 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 25.01.2008 -- 29.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Crallous D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength

I ÇOK DAYANIMLI	Strong
II DAYANIMLI	M.Strong
III ORTA	M.Weak
IV ZAYIF	Weak
V ÇOK ZAYIF	V.Weak

AYRIŞMA/Weathering

I TAZE	Fresh
II AZ AYRIŞMIŞ	Slightly W.
III ORTA D. AYR.	Mod. Weath.
IV ÇOK AYR.	Highly W.
V TÜMÜYLE AYR.	Comp. W.

İNCE DANELİ/Fine Grained

N : 0-2	ÇOK YUMUŞAK	Very Soft
N : 3-4	YUMUŞAK	Soft
N : 5-8	ORTA KATI	Moderately Stiff
N : 9-15	KATI	Very Stiff
N :16-30	ÇOK KATI	Stiff
N : >30	SERT	Hard

İRİ DANELİ/Coarse Grained

N : 0-4	ÇOK GEVŞEK	Very Loose
N : 5-10	GEVŞEK	Loose
N : 11-30	ORTA SIKI	Moderately Dense
N : 31-50	SIKI	Dense
N : >50	ÇOK SIKI	Very Dense

KAYA KALİTESİ TANIMI/RQD

% 0-25 ÇOK ZAYIF	Very Poor
% 25-50 ZAYIF	Poor
% 50-75 ORTA	Fair
% 75-90 İYİ	Good
% 90-100 ÇOK İYİ	Excellent

KIRIKLAR-30 cm/Fractures

1	SEYREK	Wide (W)
1-2	ORTA	Moderate (M)
2-10	SIK	Close (Cl)
10-20	ÇOK SIKI	Intense (I)
>20	PARÇALI	Crushed (Cr)

ORANLAR/Proportions

% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 5-15	AZ	Little	% 5-20	AZ	Little
% 15-35	ÇOK	Very	% 20-5	ÇOK	Very

SPT STANDART PENETRASYON TESTİ / Standard Peneration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	Sample Type / NUMUNE CİNSİ	Run / MANEVRA BOYU	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
29,0		RC															
30,0		RC						Brownish pink, moderately weathered, moderate weak ANDESITE. The discontinuity surfaces are stained and rough.			III	W3		51	20	17
31,0								Perpendicular cracks are observed			III	W3		35	17		18
32,0		RC									I	W5					
33,0											III	W3					
34,0								Clayey, sandy, very weak ANDESITE observed at the depths of 31,50-32,00 m and 33,00-33,50 m			I	W5		41	8		19
35,0								End Of Borehole	35,00		III	W3					
36,0																	
37,0																	
38,0																	
39,0																	
40,0																	
41,0																	
42,0																	

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-8

SAYFA / Page 1 / 3

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+965/Left tube	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+965	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 25.01.2008 -- 29.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained			İRİ DANELİ/Coarse Grained		
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2	ÇOK YUMUŞAK	Very Soft	N : 0-4	ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4	YUMUŞAK	Soft	N : 5-10	GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8	ORTA KATI	Moderately Stiff	N : 11-30	ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15	KATI	Very Stiff	N : 31-50	SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30	ÇOK KATI	Stiff	N : >50	ÇOK SIKI	Very Dense
				N : >30	SERT	Hard			

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures			ORANLAR/Proportions				
% 0-25	ÇOK ZAYIF	Very Poor	1	SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50	ZAYIF	Poor	1-2	ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75	ORTA	Fair	2-10	SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90	İYİ	Good	10-20	ÇOK SIKI	Intense (I)						
% 90-100	ÇOK İYİ	Excellent	>20	PARÇALI	Crushed (Cr)						

SPT STANDART PENETRASYON TESTİ / Standard Penetration Test
D ÖRSELENMİŞ NUMUNE / Disturbed Sample
UD ÖRSELENMEMİŞ NUMUNE / Undisturbed Sample
K KAROT NUMUNESİ / Core Sample
P PRESİYOMETRE DENEYİ / Pressuremeter Test
VS VEYN DENEYİ / Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
0,0																	
1,0		RC						Pink-brown, clayey, sandy, blocky COLLUVIUM						33	0		1
2,0		RC												34	0		2
3,0		RC												39	0		3
4,0		RC												37	0		4
5,0		RC															
6,0		RC							6,00								
7,0		RC						Pink, slightly weathered-moderately weathered, moderate strong ANDESITE			III	W2-W3		67	43		5
8,0		RC									III	W2-W3		55	45		6
9,0		RC						The discontinuity surfaces are rough and stained(limonited).			III	W2-W3		64	20		7
10,0		RC									III	W2-W3		60	44		8
11,0		RC									III	W2-W3		79	35		9
12,0		RC									III	W2-W3					
13,0		RC									III	W2-W3		87	67		10
14,0																	

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued

SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-8

SAYFA / Page 2 / 3

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+965/Left tube	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+965	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 25.01.2008 -- 29.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained			İRİ DANELİ/Coarse Grained		
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2	ÇOK YUMUŞAK	Very Soft	N : 0-4	ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4	YUMUŞAK	Soft	N : 5-10	GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8	ORTA KATI	Moderately Stiff	N : 11-30	ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15	KATI	Very Stiff	N : 31-50	SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N :16-30	ÇOK KATI	Stiff	N : >50	ÇOK SIKI	Very Dense
				N : >30	SERT	Hard			

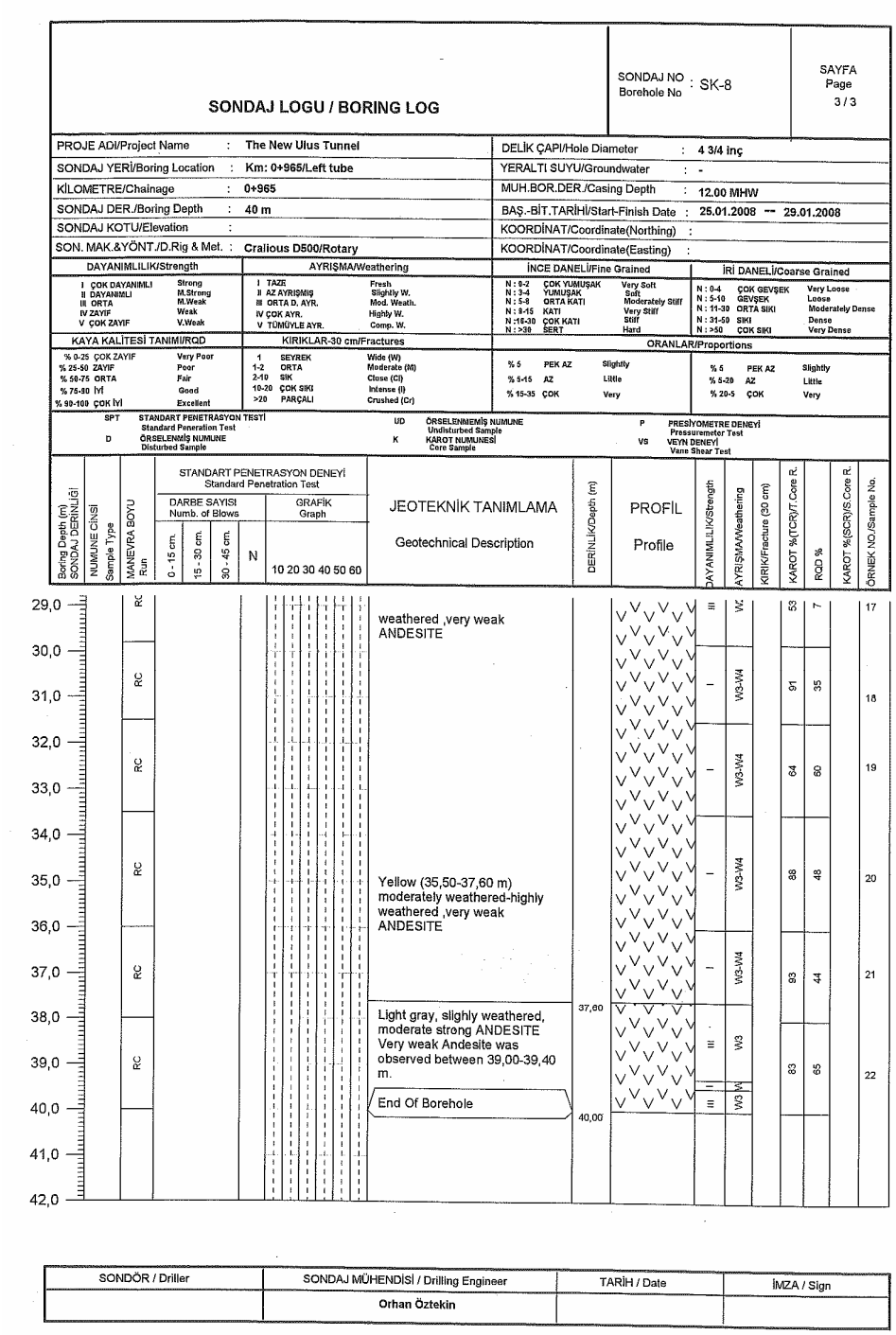
KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures		ORANLAR/Proportions					
% 0-25 ÇOK ZAYIF	Very Poor	1 SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50 ZAYIF	Poor	1-2 ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75 ORTA	Fair	2-10 SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90 İYİ	Good	10-20 ÇOK SIKI	Intense (I)						
% 90-100 ÇOK İYİ	Excellent	>20 PARÇALI	Crushed (Cr)						

SPT	STANDART PENETRASYON TESTİ Standard Penetration Test	UD	ÖRSELENMEMİŞ NUMUNE Undisturbed Sample	P	PRESİYOMETRE DENEYİ Pressuremeter Test
D	ÖRSELENMİŞ NUMUNE Disturbed Sample	K	KAROT NUMUNESİ Core Sample	VS	VEYN DENEYİ Vane Shear Test

Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test: DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
15,0								Pink, slightly weathered-moderately weathered, moderate strong ANDESITE				W					
16,0	RC							The discontinuity surfaces are rough and stained(limonited).			III	W2-W3		60	35		11
17,0									17,00								
18,0	RC										III	W2-W3		51	40		12
19,0																	
20,0	RC							Pink-dark brown(17,00-21,50 m) moderately weathered, moderate weak ANDESITE.			–	W3-W4		53	13		13
21,0								Yellow-light pink, moderately weathered-highly weahered									
22,0	RC										I	W3-W4		73	60		14
23,0																	
24,0	RC										–	W3-W4		50	31		15
25,0																	
26,0	RC																
27,0								Pink, slightly weathered, moderate strong ANDESITE The discontinuity surfaces are rough and stained(limonited).	26,60		–	W3-W4		95	79		16
28,0								Pink-gray (28,00-35,50m)	28,00								

SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

Continued



SONDAJ LOGU / BORING LOG

SONDAJ NO / Borehole No : SK-8

SAYFA / Page 3 / 3

PROJE ADI/Project Name	: The New Ulus Tunnel	DELİK ÇAPI/Hole Diameter	: 4 3/4 inç
SONDAJ YERİ/Boring Location	: Km: 0+965/Left tube	YERALTI SUYU/Groundwater	: -
KİLOMETRE/Chainage	: 0+965	MUH.BOR.DER./Casing Depth	: 12.00 MHW
SONDAJ DER./Boring Depth	: 40 m	BAŞ.-BİT.TARİHİ/Start-Finish Date	: 25.01.2008 -- 29.01.2008
SONDAJ KOTU/Elevation	:	KOORDİNAT/Coordinate(Northing)	:
SON. MAK.&YÖNT./D.Rig & Met.	: Cralious D500/Rotary	KOORDİNAT/Coordinate(Easting)	:

DAYANIMLILIK/Strength		AYRIŞMA/Weathering		İNCE DANELİ/Fine Grained			İRİ DANELİ/Coarse Grained		
I ÇOK DAYANIMLI	Strong	I TAZE	Fresh	N : 0-2	ÇOK YUMUŞAK	Very Soft	N : 0-4	ÇOK GEVŞEK	Very Loose
II DAYANIMLI	M.Strong	II AZ AYRIŞMIŞ	Slightly W.	N : 3-4	YUMUŞAK	Soft	N : 5-10	GEVŞEK	Loose
III ORTA	M.Weak	III ORTA D. AYR.	Mod. Weath.	N : 5-8	ORTA KATI	Moderately Stiff	N : 11-30	ORTA SIKI	Moderately Dense
IV ZAYIF	Weak	IV ÇOK AYR.	Highly W.	N : 9-15	KATI	Very Stiff	N : 31-50	SIKI	Dense
V ÇOK ZAYIF	V.Weak	V TÜMÜYLE AYR.	Comp. W.	N : 16-30	ÇOK KATI	Stiff	N : >50	ÇOK SIKI	Very Dense
				N : >30	SERT	Hard			

KAYA KALİTESİ TANIMI/RQD		KIRIKLAR-30 cm/Fractures			ORANLAR/Proportions					
% 0-25	ÇOK ZAYIF	Very Poor	1	SEYREK	Wide (W)	% 5	PEK AZ	Slightly	% 5	PEK AZ	Slightly
% 25-50	ZAYIF	Poor	2-10	ORTA	Moderate (M)	% 5-15	AZ	Little	% 5-20	AZ	Little
% 50-75	ORTA	Fair	10-20	SIK	Close (Cl)	% 15-35	ÇOK	Very	% 20-5	ÇOK	Very
% 75-90	İYİ	Good	>20	ÇOK SIKI	Intense (I)						
% 90-100	ÇOK İYİ	Excellent		PARÇALI	Crushed (Cr)						

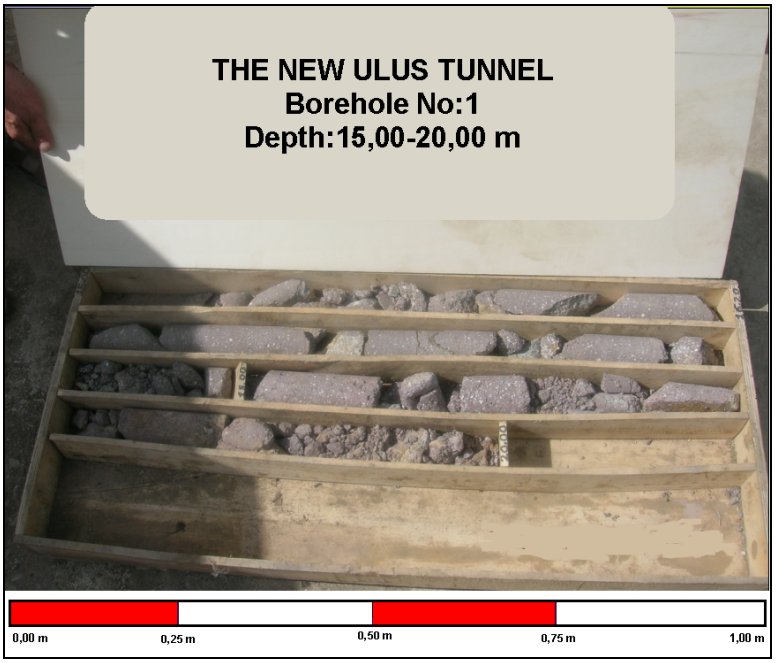
SPT Standart Penetration Test — D Örselenmiş Numune / Disturbed Sample — UD Örselenmemiş Numune / Undisturbed Sample — K Karot Numunesi / Core Sample — P Presiyometre Deneyi / Pressuremeter Test — VS Vevn Deneyi / Vane Shear Test

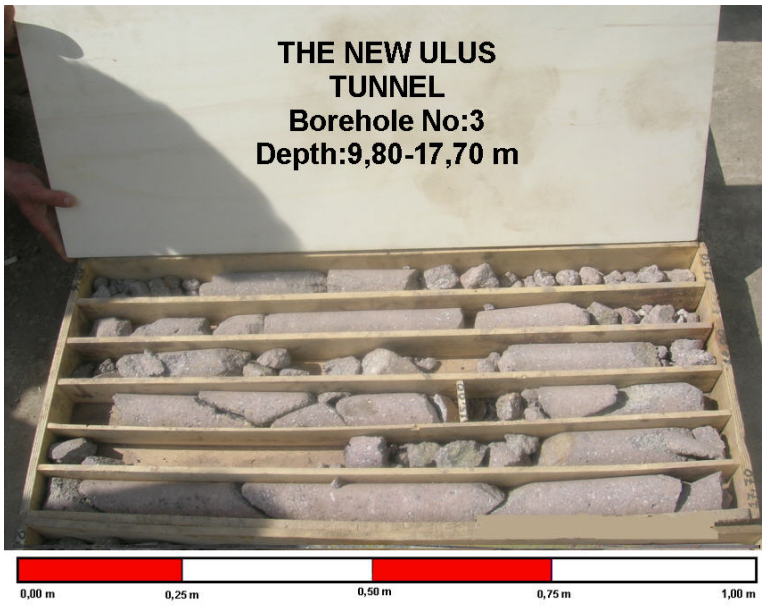
Boring Depth (m) / SONDAJ DERİNLİĞİ	NUMUNE CİNSİ / Sample Type	MANEVRA BOYU / Run	STANDART PENETRASYON DENEYİ / Standard Penetration Test — DARBE SAYISI / Numb. of Blows: 0 - 15 cm.	15 - 30 cm.	30 - 45 cm.	N	GRAFİK / Graph: 10 20 30 40 50 60	JEOTEKNİK TANIMLAMA / Geotechnical Description	DERİNLİK/Depth (m)	PROFİL / Profile	DAYANIMLILIK/Strength	AYRIŞMA/Weathering	KIRIK/Fracture (30 cm)	KAROT %(TCR)/T.Core R.	RQD %	KAROT %(SCR)/S.Core R.	ÖRNEK NO./Sample No.
29,0		RC						weathered ,very weak ANDESITE			III	W4		53	7	17
30,0		RC									I	W3-W4		91	35		18
31,0																	
32,0		RC									I	W3-W4		64	60		19
33,0																	
34,0		RC									I	W3-W4		88	48		20
35,0								Yellow (35,50-37,60 m) moderately weathered-highly weathered ,very weak ANDESITE									
36,0		RC									I	W3-W4		93	44		21
37,0																	
38,0		RC						Light gray, slighly weathered, moderate strong ANDESITE Very weak Andesite was observed between 39,00-39,40 m.	37,60		III	W3		83	65		22
39,0																	
40,0		RC						End Of Borehole	40,00		III	W3					
41,0																	
42,0																	

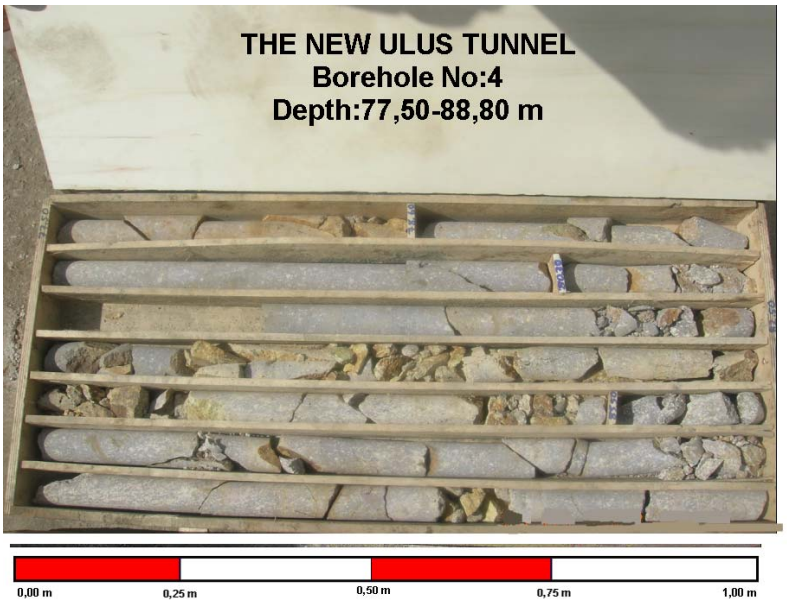
SONDÖR / Driller	SONDAJ MÜHENDİSİ / Drilling Engineer	TARİH / Date	İMZA / Sign
	Orhan Öztekin		

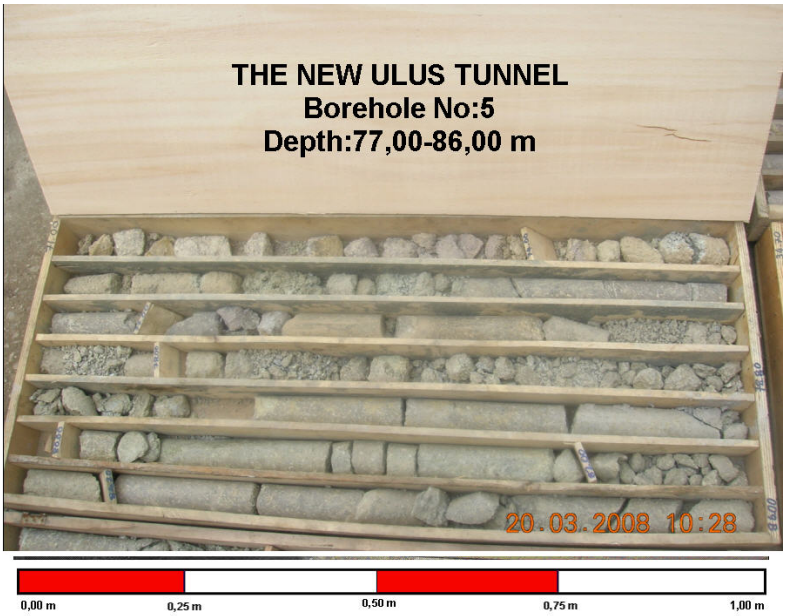
APPENDIX D

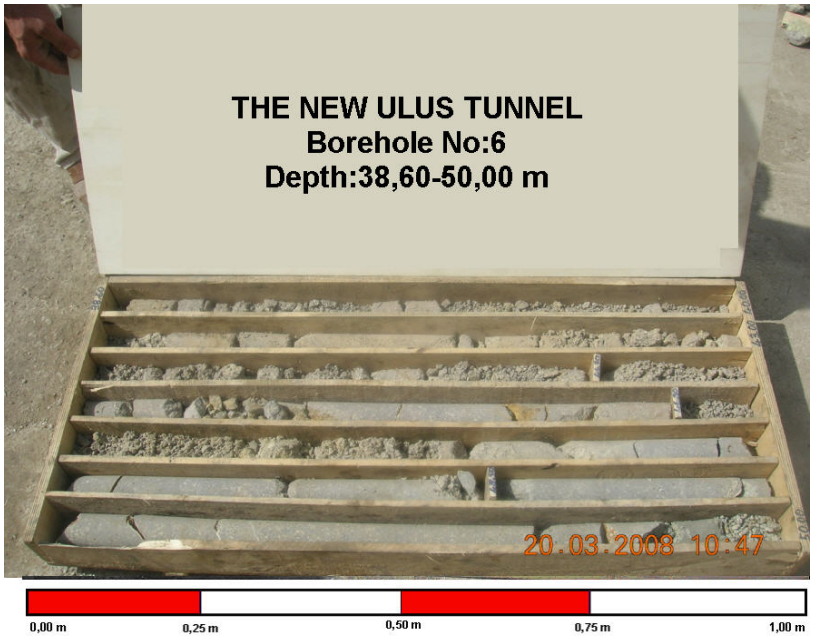
The core photographs




THE NEW ULUS
TUNNEL
Borehole No:3
Depth:9,80-17,70 m
0,00 m
0,25 m
0,50 m
0,75 m
1,00 m


THE NEW ULUS TUNNEL
Borehole No:4
Depth:77,50-88,80 m
0,00 m
0,25 m
0,50 m
0,75 m
1,00 m


THE NEW ULUS TUNNEL
Borehole No:5
Depth:77,00-86,00 m
20.03.2008 10:28
0,00 m
0,25 m
0,50 m
0,75 m
1,00 m


THE NEW ULUS TUNNEL
Borehole No:6
Depth:38,60-50,00 m
20.03.2008 10:47
0,00 m
0,25 m
0,50 m
0,75 m
1,00 m


THE NEW ULUS TUNNEL
Borehole No:7
Depth:24,00-35,00 m
20.03.2008 10:57
0,00 m
0,25 m
0,50 m
0,75 m
1,00 m


THE NEW ULUS TUNNEL
Borehole No:8
Depth:10,50-21,50 m
0,00 m
0,25 m
0,50 m
0,75 m
1,00 m