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M.A. Thesis in Geography

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COSMOGENIC DATING OF GLACIAL LANDFORMS ON AKDAĞ (WESTERN TAURUS) AND IMPACT ON CONTEMPORARY HUMAN ACTIVITIES

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ABSTRACT

Himmet HAYBAT **May 2013**

COSMOGENIC DATING OF GLACIAL LANDFORMS ON AKDAĞ (WESTERN TAURUS) AND IMPACT ON CONTEMPORARY HUMAN ACTIVITIES

The Eastern Mediterranean region provide significant information on glaciations and climates of the Quaternary. The aim of the study is to determine the distribution of glaciations, its cosmogenic surface exposure ages of glacial deposits exposed on Akdağ (Southwestern Turkey). I also analyzed the present human activities in the region. Akdağ (36.54^{0}N, 29.57^{0}E, 3016 m) is located at the southwest corner of Turkey, very close to the Mediterranean. During the field trips to the study area, 41 rock samples were collected from the moraine deposits in order to calculate the cosmogenic Cl-36 ages of the moraines in three glacier valleys. The samples were made prepared at Kozmo-Lab located at the Fatih University, Istanbul, Turkey and their isotopic ratios was measured at CNRS-ASTER Accelerator Mass Spectrometer in France. Results showed that the glaciers in Akdağ reached the maximum length of 6 km from their cirques during the Last Glacial Maximum (LGM, about 21 ka: thousand years ago). The moraines from where the samples were collected were at the altitudes between 2000-2200 meters above the sea level. The ages of moraines are in between 23.3±0.7 ka and 20.4±0.8 ka. Furthermore, pre-LGM glaciers were also determined for the first time in Turkish mountains. Their age results gave about 37.9 ka. Late Glacial moraine deposits were found to be 17.2 ka in the field of study. Dating results show consistency with the mountains in Turkey as well as in other parts of Europe. Transhumance activities in Akdağ were also analyzed with survey and interview methods. The surveys and interviews were carried out in thirty one families at four different plateau settlements (*yayla*). According to the results, the transhumant people migrate to the yayla settlement during summer months for the purposes of livestock, beekeeping and relaxation. This study attempted to find out the problems of the people at Akdağ and tried to propose solutions to the problems prevalent in the region.

Key words: Cosmogenic Exposure Dating, Transhumance, The Western Taurus, Akdağ, Glacier, Moraine

KISA ÖZET

Himmet HAYBAT **Mayıs 2013**

AKDAĞ'DA (BATI TOROSLAR) BUZUL YERŞEKİLLERİNİN KOZMOJENİK YAŞLANDIRILMASI VE GÜNCEL BEŞERİ FAALİYETLER ÜZERİNE ETKİSİ

Akdeniz'in doğusunda bulunan bölgeler günümüz öncesine ait buzullaşmaların ve iklimlerin hakkında bilgiler sunmaktadır. Bölgede bulunan güncel buzullaşma bölgelerinde yürütülen beşeri faaliyetler de çalışma alanında aktif bir şekilde yürütülmektedir. Çalışmanın amacı bölgedeki eski buzullaşmaların dağılımını, kozmojenik yüzeylenme yaşlarını belirlemek ve bu bölgedeki güncel beşeri faaliyetleri incelemektir. Amaca yönelik olarak Türkiye'nin güneybatısında bulunan Akdağ (36.54^{0}K, 29.57^{0}D, 3016 m) seçilmiştir. Arazi çalışması sırasında kozmojenik Cl-36 tarihlendirme yöntemine uygun olarak, moren bloklarından 41 adet kayaç örneği alınmıştır. Ayrıca, arazi çalışması sırasında bölgede bulunan üç buzul vadisinin haritası hazırlanmıştır. Araziden alınan örnekler Fatih Üniversitesi'nde bulunan Kozmo-Lab'da hazırlanarak, izotop oranları Fransa'da bulunan CNRS-ASTER Hızlandırıcılı Kütle Spektometresi'nde ölçülmüştür. Analiz sonucunda Akdağ'daki buzulların yaklaşık olarak 6 km uzunluğa ulaştıkları tespit edilmiştir. Son Buzul Maksimumu (LGM, günümüzden 21 bin yıl önce) sırasında depolanan morenlerin deniz seviyesinden yüksekliği 2000-2200 metre arasında bulunmaktadır. Kozmojenik tarihlendirme yöntemi kullanılarak bölgede ölçülen LGM morenlerinin yaşları 23.3±0.7 bin yıl ile 20.4±0.8 bin yıl arasında değişmektedir. Ayrıca, çalışma alanında Son Maksimum Buzullaşma dönemi öncesine (37.9 bin yıl) ve sonrasına (17.2 bin yıl) ait buzullarında varlığı saptanmıştır. Elde edilen sonuçlar Akdağ'ın çevresinde bulunan diğer dağlarla ve ülkemizin ve Avrupa'nın diğer bölgeleri ile tutarlılık göstermektedir. Ayrıca çalışmada Akdağ'da bulunan yaylacılık faaliyetleri incelenmiştir. Bu amaçla, anket ve mülakat çalışmaları yapılmıştır. Anket ve mülakatlar dört farklı yayla yerleşim yerlerin toplam otuz bir hanede gerçekleştirilmiştir. Uygulanan anketler ve mülakatlar sonucunda yaylacıların hayvancılık, arıcılık ve dinlenme amacıyla yayla yerleşim alanlarını çıktıkları belirlenmiştir. Yayladaki insanların problemlerini ve yayla hayatını kayıt altına almak amacıyla gerçekleştirilen bu çalışmanın, bölgede yaşanan problemleri ortaya çıkarmasında katkı sağladığı düşünülmektedir.

Anahtar Kelimeler: Kozmojenik Yüzey Yaşlandırma, Yaylacılık, Batı Toroslar, Akdağ, Buzul, Moren

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LIST OF ABBREVIATIONS

ACE: Age Calculation Engine

AMS: Accelerated Mass Spectrometer

DEM: Digital Elevation Model

ELA: Equilibrium Line Altitudes

GIS: Geographic Information System

GPS: Global Positioning System

LG: Late Glacial

LGM: Last Glacial Maximum

ICP-MS: Inductively Coupled Plasma – Mass Spectrometer

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CHAPTER I: INTRODUCTION

1.1. Purpose of the current study

The study has two primary objectives. The first objective is to examine glaciations and paleoclimate in Akdağ. The second objective is to investigate the human activities in the research area. First of all the geo-morphological traces that Late Quaternary glaciers of Akdağ left on the mountain was analyzed. As the continuation of the research, dating task was carried out on the rock samples, from the moraine sets found in the research site and detailed information on the paleo-climate was obtained. The main objective, while analyzing the paleoclimate, was to obtain detailed information on the climate in which glaciers were formed in their formation periods. The technique, used while dating glaciers, was cosmogenic ^{36}Cl dating technique. The surface dating of moraines, formed by glaciers, was determining with this unique technique. The main objective of this method is to determine the surfacing dates of the moraines sets and to calculate their age of formation. While analyzing the human activity, which is one of the other objective of this research, the living conditions of transhumans located in Akdağ were analyzed in details. The subject was gathered under three main headings as social, economic and cultural while analyzing the activities of human actions in the region.

1.2. Study area

1.2.1. Physical setting

Akdağ is located in the southwest of Turkey (36.32°N, 29.34°D, 3016 m above mean sea level). Situated on the west of Taurus Mountain range that runs parallel to the Mediterranean Sea, Akdağ is located between the provincial boundaries of Antalya and Muğla (Figure 1).

Akdağ is on the further west of the Taurus Mountains which bears one of the highest peak of the Taurus Mountains. Located 100 km west of the Gulf of Antalya, Akdağ is in the north of Kaş and lies between Eşen Valley and Elmalı Polje. The study area is, located within D4 quadrangle of Fethiye O23 parcel at the scale of

1/25000, and is approximately 75 km^2. The study area is 120 km away from Antalya by paved road and is in 150 km distant of Muğla. Major settlements located nearby Akdağ are Elmalı and Kaş districts as well as Akçay and Gömbe towns of Antalya. The altitude of Akdağ's peak is 3016 km above the mean sea level.

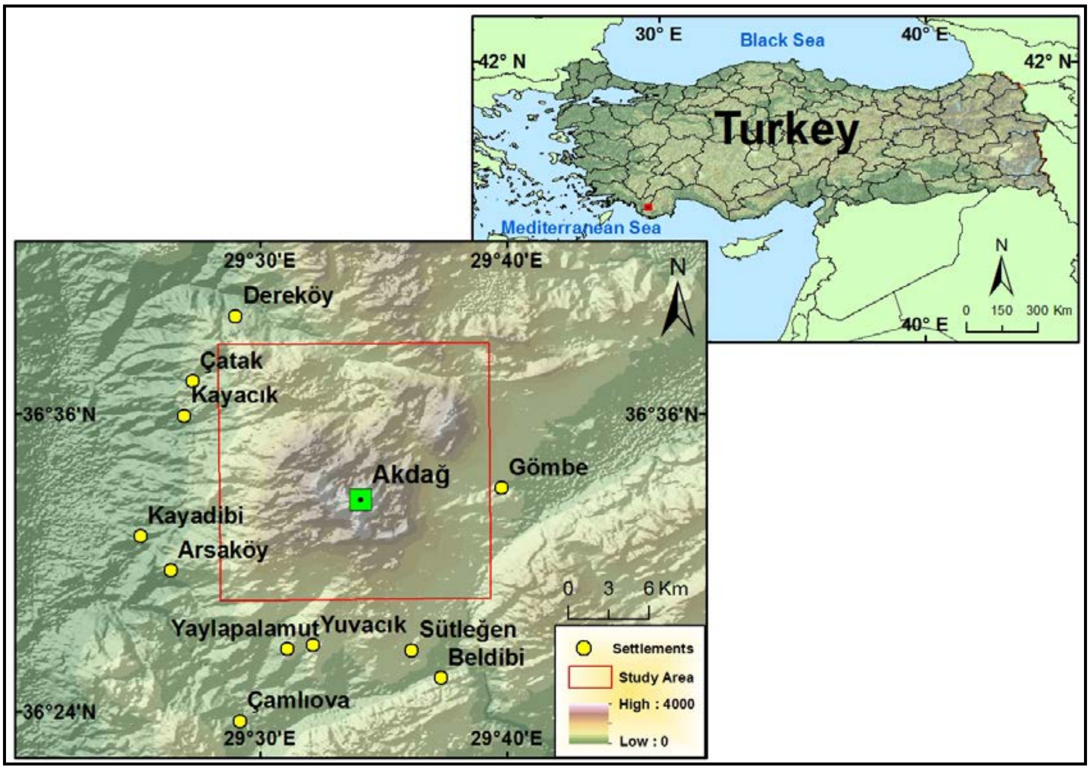


Figure 1. Location map of the study area

There is no common drainage network due to intense karstification in the region. The largest river of the study area is Eşen River. Other streams are Koca and Kıbrıs Rivers. The mean total of annual precipitation is about 900 mm whereas the mean yearly temperature is 13°C.

Vegetation is more intensely developed in the lowlands. Generally vegetation, composed of pine trees and bushes in scrub. Forest vegetation stops approximately at after 1800 m, and they do not exist in the highest parts of Akdağ.

The main source of livelihood in the region is agriculture and animal husbandry and transhumance was also carried out in high areas. The areas of karstic depression that filled with alluvial deposits are suitable for agriculture. Especially fruit cultivation has developed and has become an important source of livelihood. Apple orchards, in particular, are common in the region. Access to the region is provided by Antalya-Korkuteli-Elmalı highway through Akçay and Gömbe. In addition, transportation routes are also available from the south through Kaş. Mountain and forest passes as well as village roads are suitable to drive especially during the summer months. Transportation from the city center of Antalya Province is approximately 1.5 hours by car whereas it takes 45 minutes from Kaş.

The higher upper parts of Akdağ is covered with dense karstic shapes and paleoglaciers are developed on these depressions. We can assert that glaciations on the mountain occurred in the Late Pleistocene. Glacial landforms seen on the mountain are generally formed in cirques facing north and north-east and their continuation which was formed in three glacial valleys. These three valleys, from west to east, are Taşkuzluklu, Karadere and Kuruova valleys (Figure 2). Taşkuzluklu valley extends northwards. That of Karadere valley is towards the northeast and, finally, the downstream flow of Kuruova is on the direction of northeast (Doğu et al. 1996).

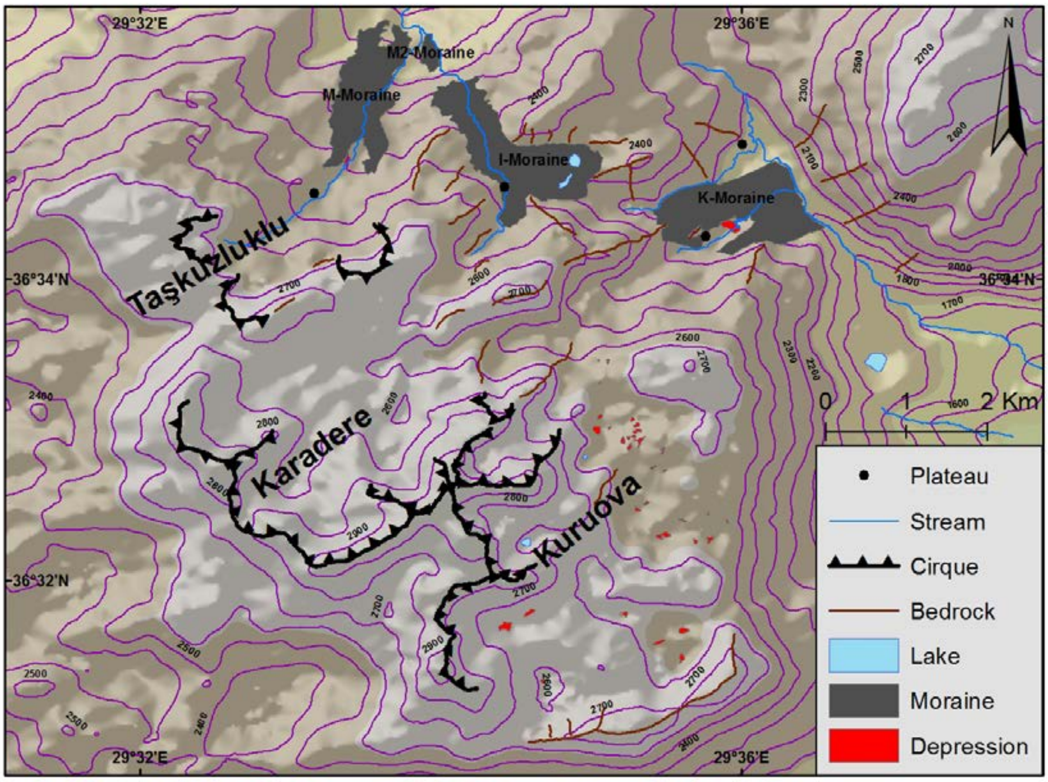


Figure 2. Map of glacial valleys in the study area

1.2.2. Geology

The first geological researches were conducted by Lucius (1925), Kirk (1932) and Colin (1962). Geological units in the region are generally classified as Beydağlar Autochthonous, Lycian and Antalya Nappes (Görür and Tüysüz, 2001). The research area and its surroundings were influenced by compressional tectonics during the Alpine orogeny (Colin, 1962). Coming from east-northeast and starting from Senonia, Antalya Nappes settled on Beydağlar Autochthonous, and Lycian Nappes, at the end of Eocene, moved south and settled on the northwest of Beydağlar Autochthonous (Şenel et al., 1989; İslamoğlu and Taner, 2002). Akdağ is situated on the southeastern edge of the Lycian Nappes and forms the highest topography of the region in Teke Peninsula after Beydağlar (Figure 3).

Akdağ is surrounded by steep slopes and it reminds of pyramid with this shape. Various karstic shapes are observed on the upper parts of the mountain. Some of these are dolines and uvalas. Karst morphology and glacial shapes can be seen together above 2250-2300 m. The ELA (Equilibrium Line Altitudes) of the mountain was determined to be 2500 m during the Würm period (Doğu et al. 1999). The average ELA of the three glacial valleys was calculated as 2482 m by the ambient-tongue method. An other method to calculate the ELA was bases of circus method and ELA is calculated as 2658 m (Table 1).

Rivers in Akdağ are generally fed by snowmelt. Thus, some water shortages were experienced towards the end of summer months. During this research, information, obtained from people living in the mountains during the summer, was seen to support this situation.

Table 1. ELA estimating

Method name	Which is applied to the glaciers at the time	How to Calculate	Name of the valley	Calculation	Result ELA (m)
Ambient-tongue method	In today's glaciers and glaciers of the Pleistocene	Average height of the hills is taken surrounds firn. Add the hills with an average height of the glacier tongue, and then divide into two.	Taşkuzluklu Karadere Kuruova	(A+B+C+D+E)/n=A' (A'+E)/2=ELA E= tongue height (2687+2756+2646+2749+2669)/5=2688 (2160+2688)/2=2424 Taşkuzluklu (3014+2879+2974+2808+2936+2590)/6=2867 (2335+2867)/2=2601 Karadere (3014+2936+2568+2590)/4=2777 (2065+2777)/2=2421 Kuruova	(2424+2601+2421)/3=2482m
Bases of circus method	Used in the past glaciers	Circus is calculated by averaging the sum of the heights of bases.	Taşkuzluklu Karadere Kuruova	A= Circus base heights (A+A+A)/3=ELA (2780+2660+2550)/3=2663 (2578+2682+2793)/3=2684 (2504+2607+2772)/3=2628	(2663+2684+2628)/3=2658m

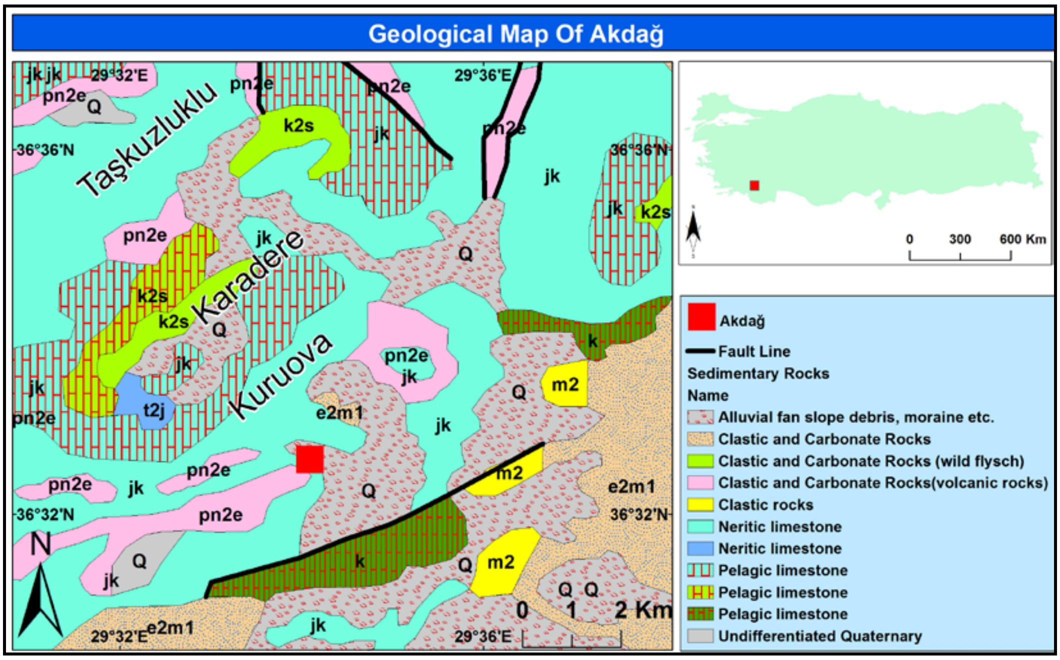


Figure 3. Geological map of the Akdağ (Maden ve Tetkik Arama, 2002)

There are five lakes on the study area. One of them is Yeşil Göl (Green Lake) (36°34’46’’ N, 29°34’53’’ E) located in the village of Çukurbağ. The elevation of Yeşil Lake is 1815 m and is situated on the east of the summit. The other lake formation is İkiz Göl (Twin Lakes) located on Akdağ (36°34’37’’ N, 29°34’49’’ E). The characteristics of these lakes are that they were formed behind the terminal moraine sets of Kurudere Valley and they are indeed very close to each other. Therefore, it is named as İkiz Lake. The elevations of İkiz Lake are 2329 m and 2332 m, respectively. They are situated on the north of the summit. In addition, there are also two smaller lakes. Their names are Büyükkara and Küçükkara Lakes (36°32’15’’ N, 29°34’34’’ E and 36°32’49’’ N, 29°34’57’’ D). The elevations are 2682 m and 2570 m, respectively and are situated on the southeast of the summit. Another important geomorphological formation is Uçarsu Waterfall. The Waterfall is located approximately 300 meters southwest of Yeşil Lake. It originates on the east of Uyluk Tepe. The water outlet elevation of Waterfall is about 1840 m. This waterfall is dry most of the year. It starts to flow at the end of April, and ends at around September (Figure 4).

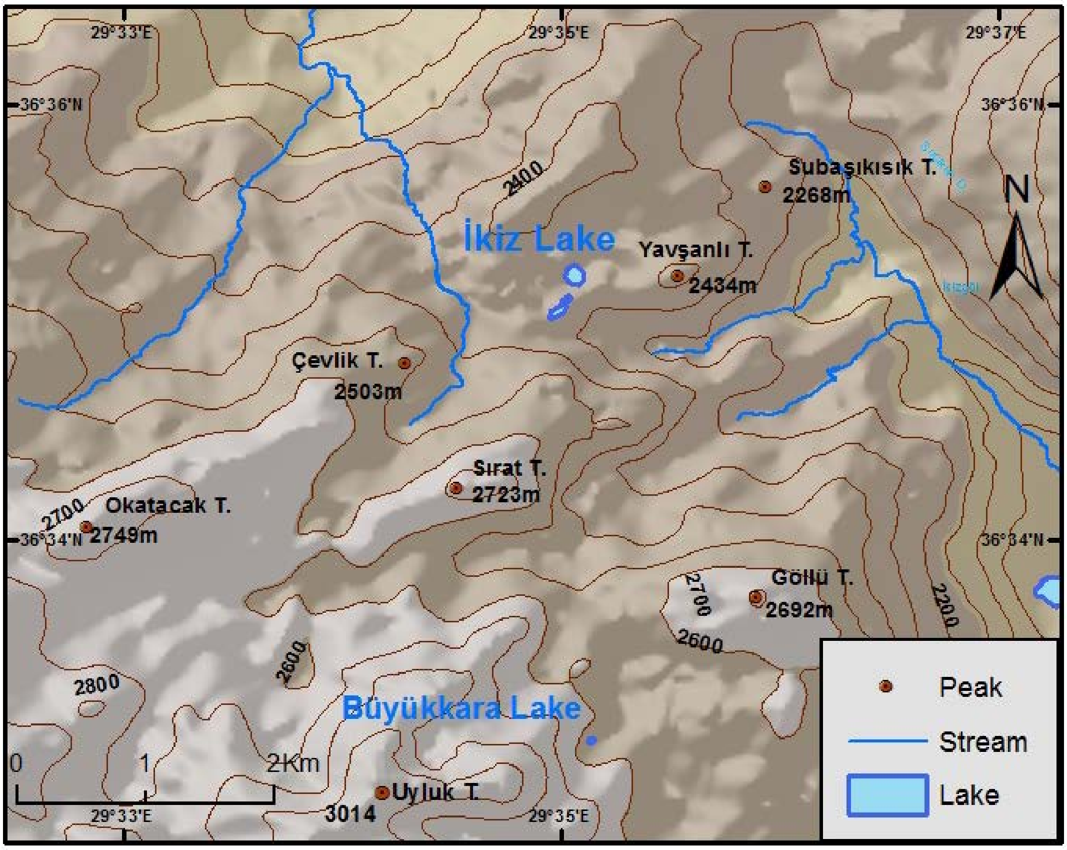


Figure 4. Hydrological map of the study area

1.2.3. Climate

Turkey is located in the temperate climate zones with its subtropical climate. Related with its location and the distribution of its landforms, Turkey leads to the occurrence of different climate types. While more temperate climate is seen in the coastal areas of the country, the effects of Northern Anatolia and Taurus mountains prevent the occurrence of temperate climate in the inland areas. For this reason, while continental climate predominate the inland parts, Mediterranean type climate is seen in the coastal areas of the country (Figure 5).

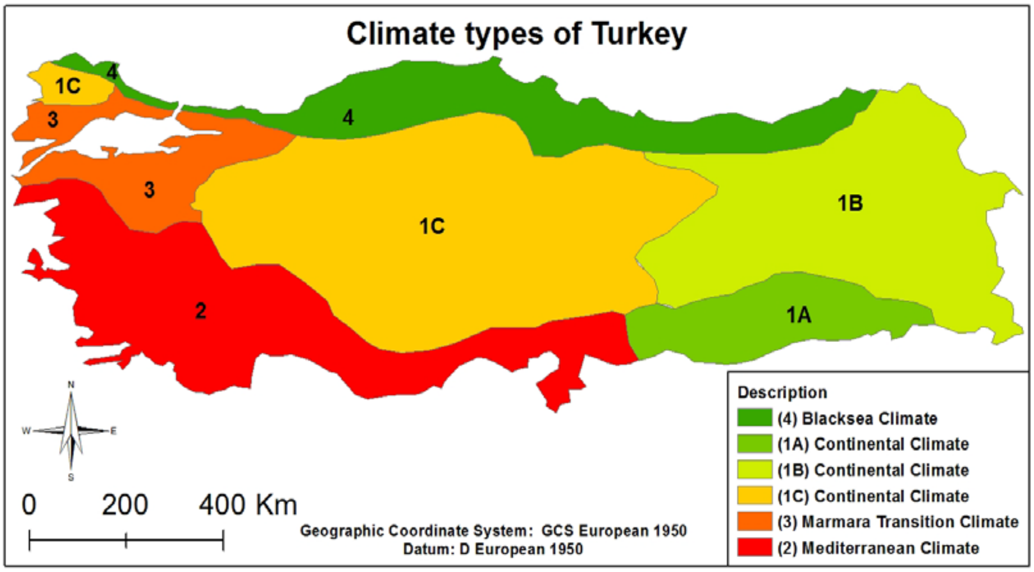


Figure 5. Climate zones of the Turkey, Source: (Atalay, 1997)

Although the Mediterranean climate dominates the research area, it is not possible to suggest that the Mediterranean climate is seen on Akdağ predominantly because the research area is over 2000 meters (Figure 6-7-8-9). Therefore, continental and mountain climate is seen in the research area depending on the elevation.

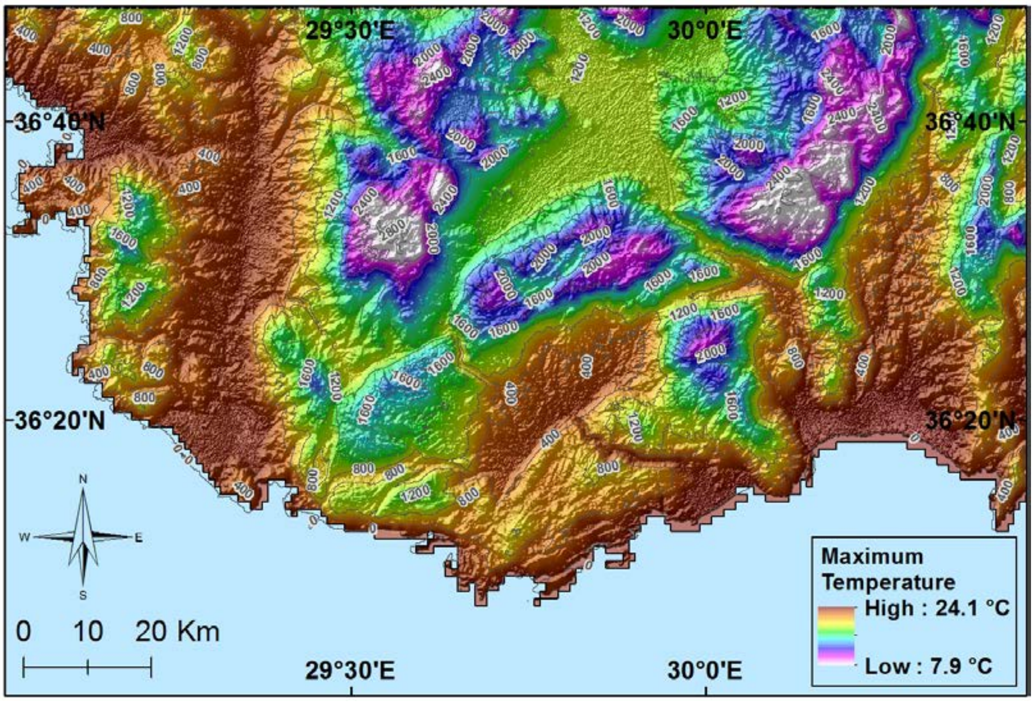


Figure 6. Maximum temperature map of the study area between the years of 1950-2000. *(http://www.worldclim.org/current, 2013)*

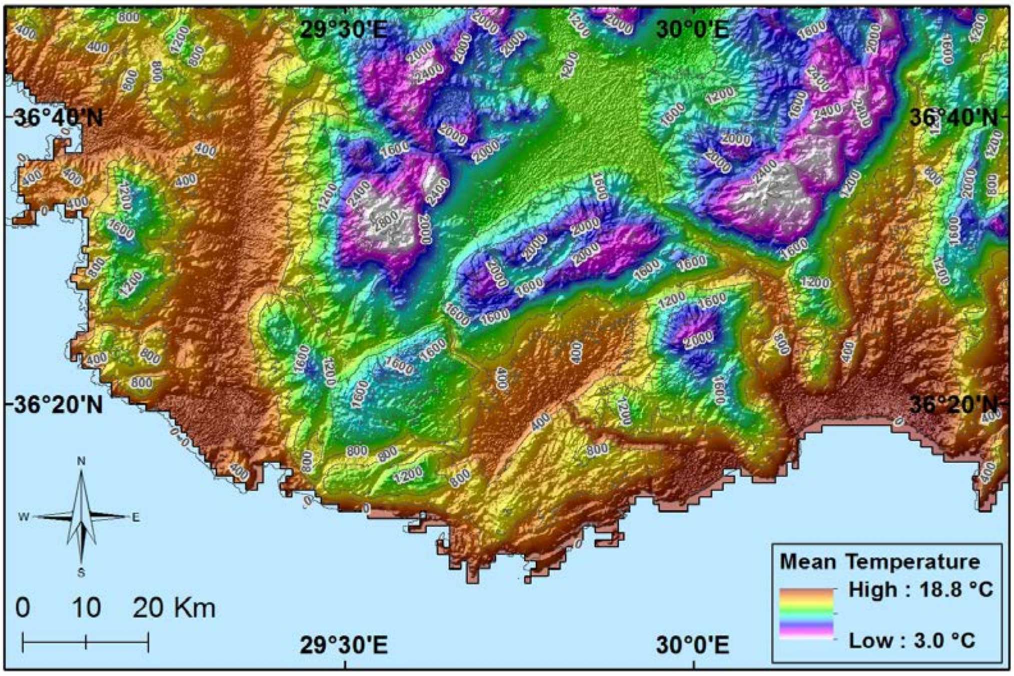


Figure 7. Mean temperature map of the study area between the years of 1950-2000. *(http://www.worldclim.org/current, 2013)*

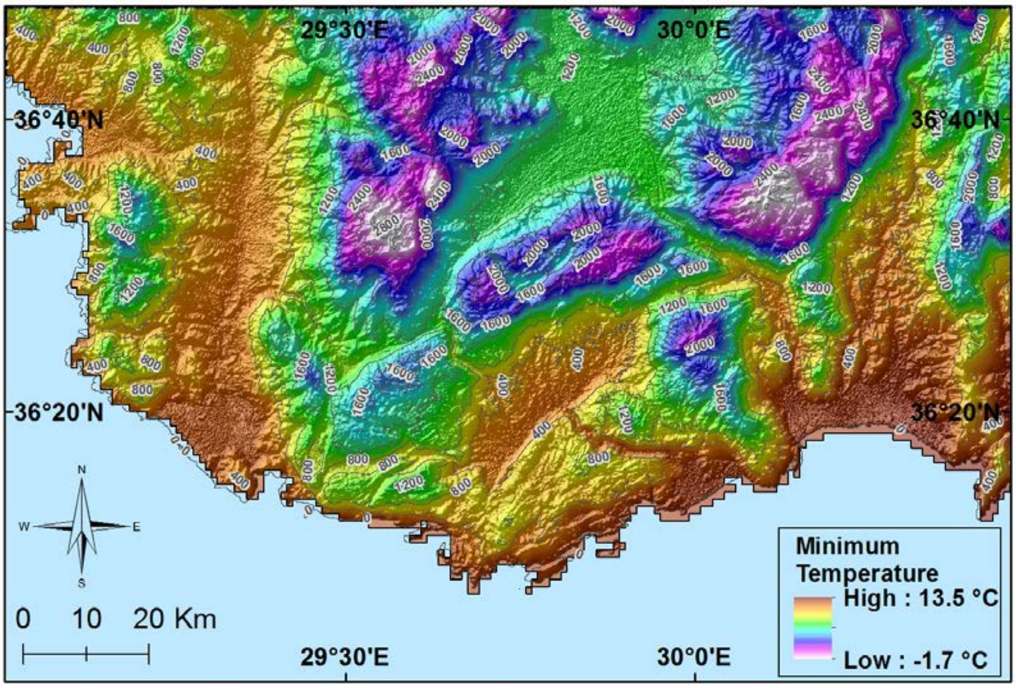


Figure 8. Minimum temperature map of the study area between the years of 1950-2000. *(http://www.worldclim.org/current, 2013)*

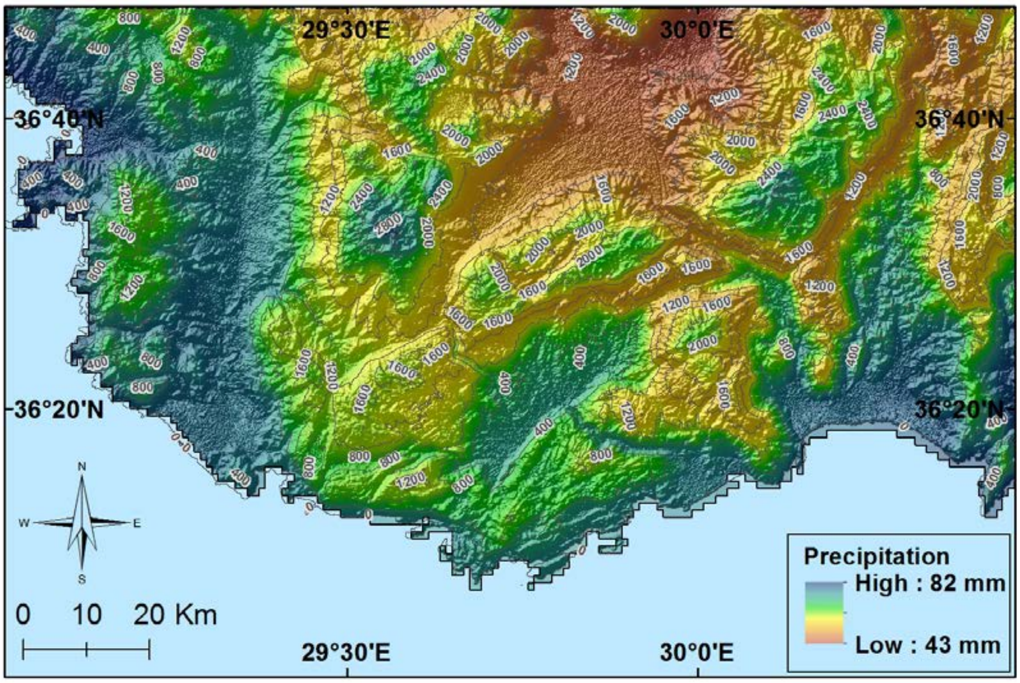


Figure 9. Average rainfall map of the study area between the years of 1950-2000. *(http://www.worldclim.org/current, 2013)*

Two district's temperature and rainfall data obatained (Table 2-3). The reason to obtained of these data was study area is located between two district (Figure 10-11-12-13-14-15).

Table 2. Temperature data table for each month of the 2012, the town of Kaş, Antalya *(http://www.accuweather.com/tr/tr/turkey-weather, 2013)*

Kaş - 2012						
	January	**February**	**March**	**April**	**May**	**June**
Daytime temperature (°)	13,3	14,2	17,7	21,6	25,2	32,5
	January	**February**	**March**	**April**	**May**	**June**
Night temperature (°)	4,4	4,3	7,2	11,4	15,4	20,8
	January	**February**	**March**	**April**	**May**	**June**
Precipitation (mm)	16,3	6,1	3,4	2,0	3,1	0,2
	July	**August**	**September**	**October**	**November**	**December**
Daytime temperature (°)	36,5	36,8	32,7	27,4	22,1	16,6
	July	**August**	**September**	**October**	**November**	**December**
Night temperature (°)	24,2	24,7	20,2	17,1	12,5	8,2
	July	**August**	**September**	**October**	**November**	**December**
Precipitation (mm)	0	0	0	5,6	1,9	26,9

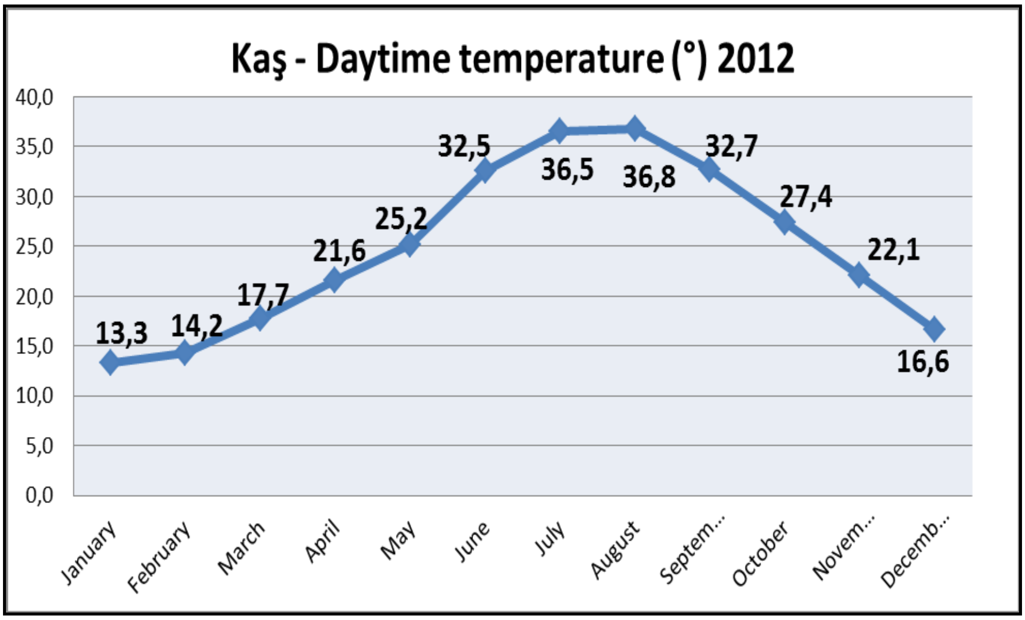


Figure 10. Average day temperature of Kaş (Antalya) in 2012 based on months *(http://www.accuweather.com/tr/tr/turkey-weather, 2013)*

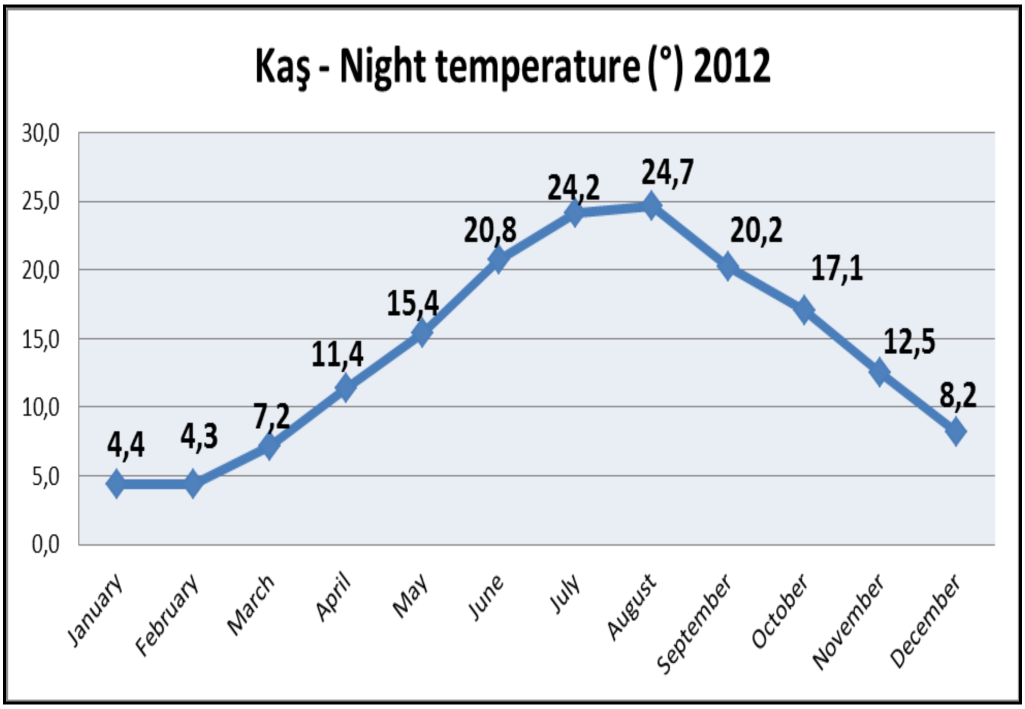


Figure 11. Average night temperature of Kaş (Antalya) in 2012 based on months *(http://www.accuweather.com/tr/tr/turkey-weather, 2013)*

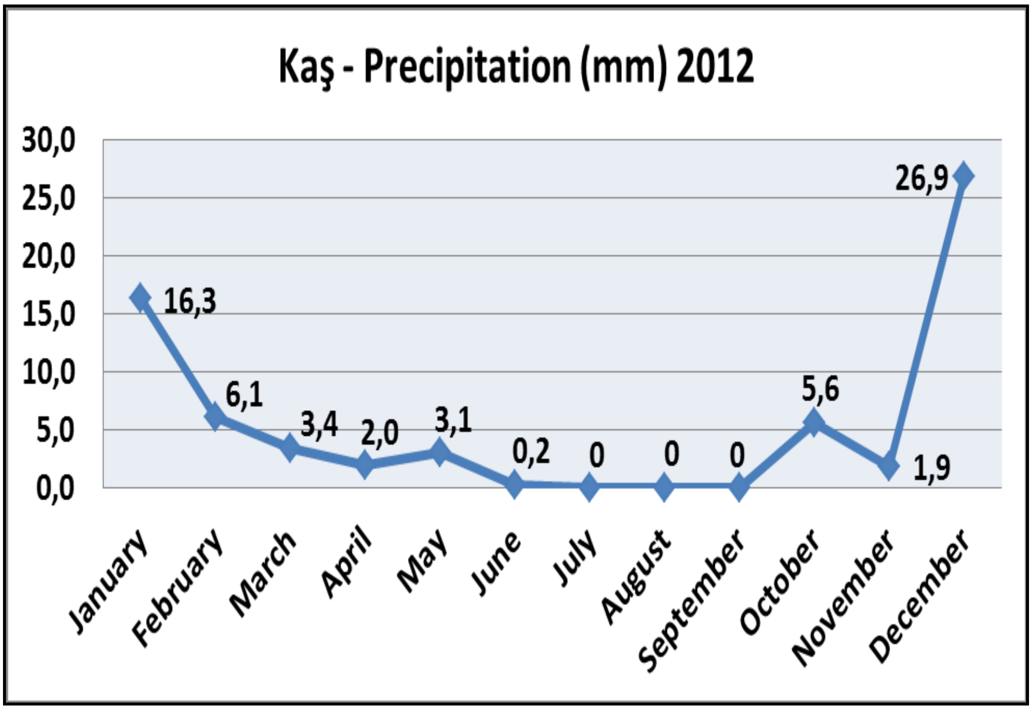


Figure 12. Average precipitation of Kaş (Antalya) in 2012 based on months *(http://www.accuweather.com/tr/tr/turkey-weather, 2013)*

Table 3. Average temperature data of Fethiye (Muğla) in 2012 based on months *(http://www.accuweather.com/tr/tr/turkey-weather, 2013)*

Fethiye - 2012						
	January	**February**	**March**	**April**	**May**	**June**
Daytime temperature (°)	8,2	10,0	14,8	20,6	23,9	33,4
	January	**February**	**March**	**April**	**May**	**June**
Night temperature (°)	0	0,1	2,7	7,5	10,6	18,2
	January	**February**	**March**	**April**	**May**	**June**
Precipitation (mm)	17,2	11,1	2,9	5,7	3,4	0
	July	**August**	**September**	**October**	**November**	**December**
Daytime temperature (°)	37,1	34,9	32,2	25,7	18,8	11,2
	July	**August**	**September**	**October**	**November**	**December**
Night temperature (°)	22,5	20,0	16,3	11,9	8,2	3,7
	July	**August**	**September**	**October**	**November**	**December**
Precipitation (mm)	0	0,1	0	1,8	1,0	21,5

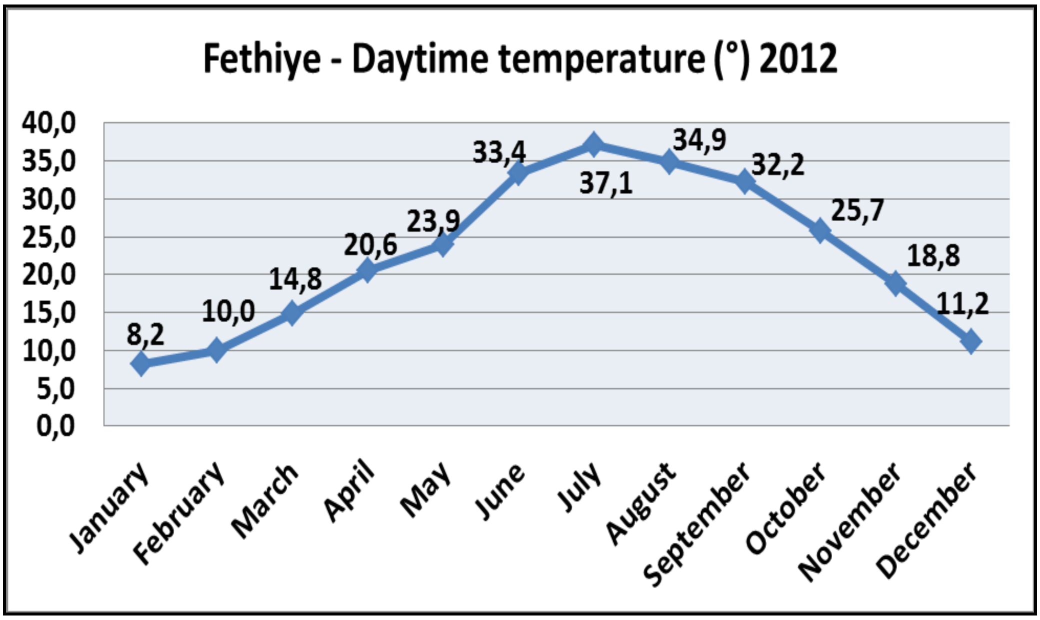


Figure 13. Average day temperature of Fethiye (Muğla) in 2012 based on months *(http://www.accuweather.com/tr/tr/turkey-weather, 2013)*

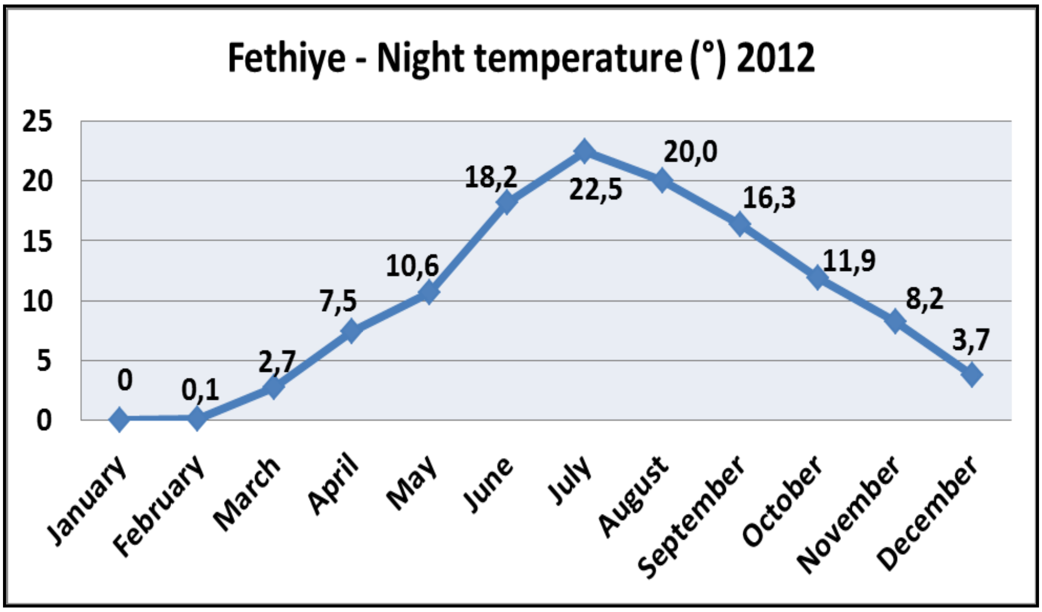


Figure 14. Average night temperature of Fethiye (Muğla) in 2012 based on months *(http://www.accuweather.com/tr/tr/turkey-weather, 2013)*

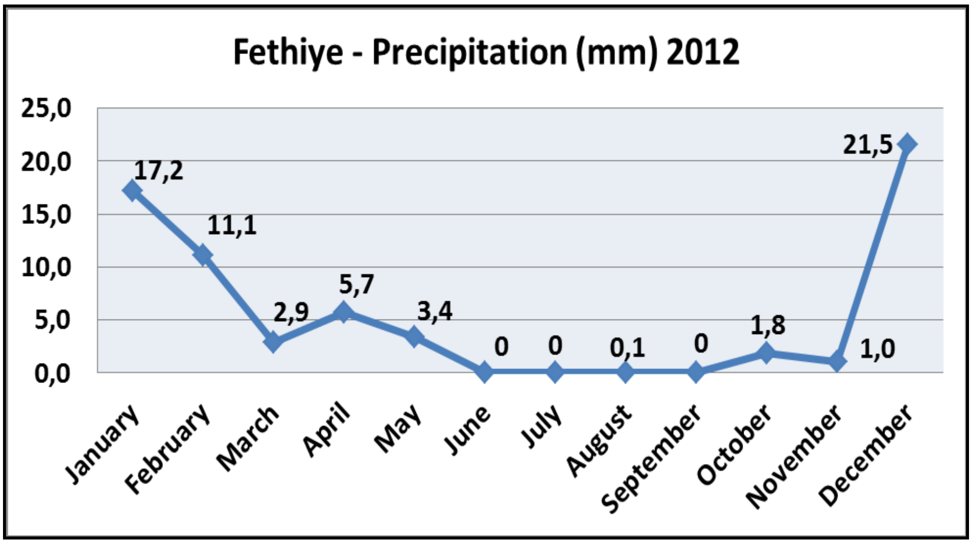


Figure 15. Average precipitation of Fethiye (Muğla) in 2012 based on months *(http://www.accuweather.com/tr/tr/turkey-weather, 2013)*

1.3. Literature survey and previous studies

Here, summaries of previous research done in the study area are presented by date.

The first study in Akdağ in terms of glaciation were done by Louis (1944) He conducted a study that examines the traces of the Pleistocene glaciations in Anatolia. Glaciations in the places such as Uludağ, Giresun, Artvin, Keşiş Mountain, Beydağları and Dumanlı mountains and Akdağ.

Yücel (1958) conducted a study called the regional geography of the central part of Teke region. The researcher, in this study, examined geo-morphology, climate, natural vegetation, habitation, population and population movements, and agriculture of the region. In addition, the differences in climate and vegetation of the coastal and inland parts of the region as a result of the study.

Messerli (1967), in his study, discussed Erciyes, Bolkar mountain in the Middle Taurus, Akdağ, Beydağları, Uludağ. In this study, issues, such as the importance of climate and permanent snow boundaries in glaciations were greatly treated.

Kalafatçıoğlu (1973), in his study, examined the geology of the western part of the Gulf of Antalya. The chronostratigraphy of the region was researched with fossils. In this stratigraphic study, the oldest rocks were discovered to be the Permian limestone and dolomites.

Özgül (1976) conducted a study called “Basic geological features of the Taurus”. In this study, it was indicated that Taurus covers sedimentary rock units in the Cambrian-Tertiary range. In addition, it was observed that it also covered ophiolites and basic submarine volcanics around Bozkır and Antalya.

Kurter and Sungur (1980) conducted a study that examined the present glaciers of Turkey. In this study, researcher divided the glaciers of Turkey into three main groups. These groups are (1) Eastern Black Sea, (2) Taurus Mountains and (3) cones of dormant volcanoes. Another point made in this study was to determine the features of mountains in which present glaciers were located.

Messerli (1980) examined the mountain glaciers in the Mediterranean as well as in Africa. Researcher indicated that only a few glaciers were formed in the Mediterranean area.

Kurter (1998) conducted a study concerning glaciers in the Middle East and Africa. Turkey’s glaciers were also included within this study. As a result of this study, total glacier area was calculated as 22.9 km^2. Besides, it was stated that modern glacier studies in Turkey did not start before 1930s. In addition, another important matter researcher indicated that detailed topographical maps were developed within 30 years.

Doğu et al. (1999) and Doğu et al. (2000) conducted a study about the glacier and karst geomorphology of Akdağ and their effect on human activities. They discovered that the karst morphology effected the mountain in the altitude range of 2250-2300 meters, intertwined with glacial shapes and with the permanent snow boundary of 2500 meters that belonged to Würm age. In other findings, they discovered that three glacier valleys were formed in Akdağ.

Çiner (2003) conducted a study called “Turkey’s current glaciers and late Quaternary glacial deposits”. The glaciers in Turkey were divided into three zones. These regions are (1) Taurus Mountains, (2) Eastern Black Sea Mountains, (3) Volcanoes and other independent mountains of Anatolia. It was discovered, in the study that two-third of current glaciers were located in Southeastern Anatolia.

Çiner et al. (2003) were examined the application of age determination method on Turkey Quaternary glacial deposits and their preliminary data were presented. They indicated that it was not possible to go beyond qualitative and relative phase in determining the ages of Quaternary glaciers without precise dating techniques. In addition, glacier sediments in different mountains of Turkey were mapped and samples for cosmogenic isotope dating were collected.

Sarıkaya et al. (2003) examined the late Quaternary glacier sediments of Erciyes volcano. The relative positions of the glaciers were determined and various features of moraines were presented as a result of the study. In addition, they emphasized that that cosmogenic age determination together with the timing of climate changes could provide a significant contribution.

Çiçek et al. (2004) examined the glacial morphology of Eastern Black Sea Mountains. In this study, they indicated that intensive glaciations took place during the Pleistocene in the mountains of Eastern Black Sea. In addition, permanent snow limit (~ELA) was found to be 2600 meters. Another issue that they dealt with was that they stated the actual glaciations limit was around 3000-3100 meters.

Tunçel et al. (2004) conducted a study on the subject of transhumance in the mountains of Eastern Black Sea. Researchers, in their study, stated that glaciers, which were formed during the Pleistocene, caused the formation of u-shaped valleys. They observed that these valleys were seen to be appropriate for transhumance. According to researchers, transhumant settled on over 1000 meters. Another issue that was stated was in the study was the practice of bee-keeping and vegetable gardening in the yayla.

Güner and Ertürk (2005) conducted a study called yayla and transhumance in Fethiye. Within the scope of the study, they reported that there were almost 500 yayla areas around Fethiye. These yayla were said to spread between 1000-1500 meters of Akdağ, Babadağ and Arı mountains. In addition, another issue indicated in the study was that even though they were part of economy in the past, these places were used as recreational areas in the last thirty years.

Hughes et al. (2006) examined the Quaternary glacial history of the mountains located in the Mediterranean. It was stated in the study that glaciations and pre-glacial movements began to be examined one hundred and twenty years ago and the study was examined in three stages. First stage is the explanation of glacial formations. Second stage is the mapping of glacial formations and third stage is to determine geochronology of glaciations by radiometric dating methods.

Hughes and Woodward (2008) examined the aging of glaciations in the last ice age. Various methods were used while conducting the dating. These methods are ^{14}C, ^{10}Be, and ^{36}Cl. As a result of the study, it was indicated the information related to paleo-climate in Italy, Greece and Turkey.

Sarıkaya et al. (2008) conducted a study called cosmogenic dating and glacier modeling of Sandıras Mountain situated in the south-west of Turkey. In this study, rock samples, taken from Sandıras Mountain, were dated. Data obtained as a result of dating showed about 20.4 ± 1.3 thousand years age, the glaciers were active.

Sarıkaya et al. (2009) examined the glaciations, paleo-climate of Erciyes Mountain by ^{36}Cl cosmogenic dating method. In the study, a total of forty-four rock samples were taken from two glacial valleys located at Erciyes Mountain. These samples were dated using ^{36}Cl method. Data also indicated that current glacier of Erciyes Mountain were retreating since 1902.

Bayrakdar and Özdemir (2010) conducted a study that examined the effect of impression factor in Kaçkar Mountain on the development of glacial and peri-glacial topography. Researchers, in this study, indicated that glacial and peri-glacial topographical shapes, depending on the impression factor, developed in different sizes and characters in the different slopes of the mountain. In addition, the effects of these factors were discovered numerically by using geographical information systems.

Ertürk and Atasoy (2010), in their study, examined transhumance in Muğla and surrounding poljes in terms of cultural geography. In the study, yayla settlements, located primarily in Muğla polje and its surrounding poljes such as Ula, Yerkesik, Yeşilyurt ve Yenice, were examined. In addition, water and soil conditions were said to dominate little and dense scrub vegetation.

Özalp and Sütlü (2011) conducted a study on the subject of examining the temporal change in transhumance carried out in the upper sections of Fırtına Basin and the determination of some environmental issues. Survey and interview methods were used in the study. It was observed by this method that there was difference between the activities in the past and those of the present. For example, while there was seen to be a decrease in the number of open homes by 15%, but an increase in the rate of climbing yayla for recreation and holiday was established by 63%.

Sarıkaya (2011) examined a study called "Turkey's current glaciers". in three regions of southeastern Taurus Mountains, mountains that extending through the coast of Eastern Black Sea and volcanic and high mountains scattered around Anatolia. In addition, satellite images, taken between the years of 2002-2009 by ASTER satellite and Google Earth software, were made use of while conducting the study.

Turoğlu (2011) conducted a study called glaciers and glacial morphology in the book he published. This published book consists of six chapters. These chapters are: general characteristics of the glaciers, classification of glaciers, glacier research, glaciations in Hydrosphere, glacial geomorphology, and polygenic geomorphology.

Bayrakdar (2012) conducted a study which examined the effect of paleo-karst in Akdağ during the Pleistocene glaciations. The goal of the study was to examine the paleo-karstic shapes in the Pleistocene glaciations that are effective in Akdağ mass. The following methods were used in this study: geographical information systems (GIS), morphometric analysis, geophysical methods, OSL dating, and sedimentological analysis. As a result of the study, it was found that traces, belonging karst and glacial geomorphology, were intertwined in the areas above 2000 meters.

Bayrakdar (2012) conducted a study about the relations between karst-glacial geomorphological analyses in Akdağ massif. The aim of the study was to investigate glasio-karst evolution in Akdağ massif. In this study used different methods, they were geographical information systems (GIS), morphometric analysis, geophysical methods, OSL dating. As a result of the OSL dates belonging to samples ages was examined 17-21 ka.

Sarıkaya (2012) investigated the retreat of the ice cap on Mount Ararat. from 1976 to 2011. The discussion on the climatic importance and shrinking of ice cao due to warming of climate was discussed in the research.

CHAPTER II: METHODOLOGY

2.1. Fields methods

The first purpose of this study was to examine the formation of paleoglaciers in Akdağ and to map their geomorphologic clues. Geomorphological maps of the research area were prepared in the field. Various programs and data were used and prepared such as follows: Google Earth, GIS, DEM (Digital Elevation Model), and Topographic Maps. Places of settlements, roads, rivers, lakes, plains, hills and contour lines are drawn on the maps. Another important issue in the field is the materials to be used while taking cosmogenic samples. Materials used while taking samples are chisel, hammer, gloves, bags for carrying samples, GPS, inclinometer and maps.

The definition of moraines during fieldtrips were done in detail. While defining moraines, they differ from each other with their modal characteristics, formation mechanisms and differences in their locations. They were defined in different stratigraphic levels. Moraines are generally divided into five distinct types. These are: lateral moraines, medial moraines, end moraines, ground moraines and ablation moraines (Turoğlu, 2011). These definitions are briefly given in the next section.

There are some important points that must be followed while taking cosmogenic samples from moraines. The determination of sampling location is related with the geomorphologic stability and geometry of the surface to be studied in detail. It should be noted while taking rock samples that they are taken from rock masses that are situated at the top of the moraine ridges. Another important rule to bear in mind is that the root of rocks should be in the matrix. An average rock sample should be taken in a way that it would weigh five-hundred grams. Another important issue to consider while taking sample is that GPS coordinates and elevation of the sampled location, from which sample was taken should be noted. In addition, azimuth angles of the surrounding topography and inclinations to horizon are noted with inclinometer (Table 4) (Figure 16-17). This is done with angles of 45° from north on clockwise. Finally, taken samples are put in a sample bag after printing their numbers on the bags.

Table 4. Azimuth angles, corrected azimuth angles and elevation data that samples taken in the study area

#	Sample ID	Topo azimuth	Topo shielding	Topo Shielding Corrections	Elevation (m)
1	AK02-601	0, 45, 90, 135, 180,225, 270, 315	0,0,11,12,16,6,10,0	0,975070302	2421
2	AK02-602	0, 45, 90, 135, 180,225, 270, 315	0,0,11,12,16,6,10,0	0,991404981	2421
3	AK02-603	0, 45, 90, 135, 180,225, 270, 315	0,0,11,12,16,6,10,0	0,997127778	2421
4	AK02-604	0, 45, 90, 135, 180,225, 270, 315	5,4,0,10,23,19,13,2	0,991175279	2350
5	AK02-605	0, 45, 90, 135, 180,225, 270, 315	5,4,0,10,23,19,13,2	0,991175279	2346
6	AK02-606	0, 45, 90, 135, 180,225, 270, 315	5,4,0,10,23,19,13,2	0,991175279	2338
7	AK02-607	0, 45, 90, 135, 180,225, 270, 315	8,8,12,5,10,6,5,6	0,998522009	2341
8	AK02-608	0, 45, 90, 135, 180,225, 270, 315	8,8,12,5,10,6,5,6	0,998522009	2334
9	AK11-609	0, 45, 90, 135, 180,225, 270, 315	0,4,6,13,11,11,6,0	0,998067622	2165
10	AK11-610	0, 45, 90, 135, 180,225, 270, 315	0,5,8,14,11,11,6,0	0,997702441	2171
11	AK11-611	0, 45, 90, 135, 180,225, 270, 315	2,2,8,10,13,11,7,3	0,997988239	2173
12	AK11-612	0, 45, 90, 135, 180,225, 270, 315	0,3,5,11,14,11,10,2	0,997560703	2289
13	AK11-613	0, 45, 90, 135, 180,225, 270, 315	0,3,6,11,14,11,9,0	0,997629207	2276
14	AK11-614	0, 45, 90, 135, 180,225, 270, 315	1,0,4,9,12,10,9,9	0,99821002	2245
15	AK11-615	0, 45, 90, 135, 180,225, 270, 315	5,5,0,7,18,11,2,9	0,997185722	2331
16	AK11-616	0, 45, 90, 135, 180,225, 270, 315	3,15,15,26,21,11,10,4	0,985225478	2173
17	AK11-617	0, 45, 90, 135, 180,225, 270, 315	3,15,15,26,21,11,10,4	0,985225478	2173

#	Sample ID	Topo azimuth	Topo shielding	Topo Shielding Corrections	Elevation (m)
18	AK11-618	0, 45, 90, 135, 180,225, 270, 315	7,16,0,18,18,13,8,3	0,988154397	2156
19	AK11-619	0, 45, 90, 135, 180,225, 270, 315	4,15,2,13,20,12,5,8	0,994462722	2154
20	AK11-620	0, 45, 90, 135, 180,225, 270, 315	7,10,0,14,12,20,12,12	0,993612482	2217
21	AK11-621	0, 45, 90, 135, 180,225, 270, 315	0,11,0,10,12,20,5,14	0,995386341	2207
22	AK11-622	0, 45, 90, 135, 180,225, 270, 315	3,11,7,4,13,11,7,18	0,996452458	2186
23	AK11-623	0, 45, 90, 135, 180,225, 270, 315	1,12,0,10,11,16,6,14	0,996624158	2186
24	AK11-624	0, 45, 90, 135, 180,225, 270, 315	0,6,12,7,9,21,7,18	0,994314002	2196
25	AK11-625	0, 45, 90, 135, 180,225, 270, 315	0,11,2,13,12,21,5,14	0,994531065	2216
26	AK11-626	0, 45, 90, 135, 180,225, 270, 315	3,9,2,13,12,19,6,10	0,975646098	2179
27	AK11-627	0, 45, 90, 135, 180,225, 270, 315	4,10,3,16,11,12,8,8	0,996850364	2168
28	AK11-628	0, 45, 90, 135, 180,225, 270, 315	0,1,5,2,4,22,20,17	0,990936966	2574
29	AK11-629	0, 45, 90, 135, 180,225, 270, 315	0,0,5,3,8,18,23,22	0,988425865	2530
30	AK11-630	0, 45, 90, 135, 180,225, 270, 315	0,5,14,15,3,14,13,10	0,995762709	2473
31	AK11-631	0, 45, 90, 135, 180,225, 270, 315	0,5,14,15,3,14,13,10	0,995762709	2490
32	AK11-632	0, 45, 90, 135, 180,225, 270, 315	0,2,16,15,3,13,5,4	0,996836585	2477
33	AK11-633	0, 45, 90, 135, 180,225, 270, 315	15,24,17,0,13,11,13,8	0,989079973	2058
34	AK11-634	0, 45, 90, 135, 180,225, 270, 315	15,24,17,0,13,11,13,8	0,989079973	2067
35	AK11-635	0, 45, 90, 135, 180,225, 270, 315	15,19,16,0,11,12,13,8	0,992261564	2073
36	AK11-636	0, 45, 90, 135, 180,225, 270, 315	1,6,16,21,14,9,8,1	0,99302925	2319
37	AK11-637	0, 45, 90, 135, 180,225, 270, 315	1,4,10,15,13,8,8,0	0,997128371	2292
38	AK11-638	0, 45, 90, 135, 180,225, 270, 315	0,2,5,10,13,9,6,1	0,998461192	2272
39	AK11-639	0, 45, 90, 135, 180,225, 270, 315	0,1,5,12,14,8,8,0	0,997991207	2284
40	AK11-640	0, 45, 90, 135, 180,225, 270, 315	0,3,6,11,13,11,8,1	0,997912874	2265
41	AK11-641	0, 45, 90, 135, 180,225, 270, 315	0,3,10,13,13,10,7,0	0,997449509	2275
42	AK11-642	0, 45, 90, 135, 180,225, 270, 315	1,4,12,7,11,6,2,0	0,998826121	2277
43	AK11-643	0, 45, 90, 135, 180,225, 270, 315	0,7,9,10,8,11,7,3	0,998497009	2277

#	Sample ID	Topo azimuth	Topo shielding	Topo Shielding Corrections	Elevation (m)
44	AK11-644	0, 45, 90, 135, 180,225, 270, 315	0,4,15,9,13,8,2,0	0,997686009	2277
45	AK11-645	0, 45, 90, 135, 180,225, 270, 315	9,6,1,19,18,12,7,0	0,994251769	2344
46	AK11-646	0, 45, 90, 135, 180,225, 270, 315	6,6,3,15,11,13,5,0	0,997459349	2345

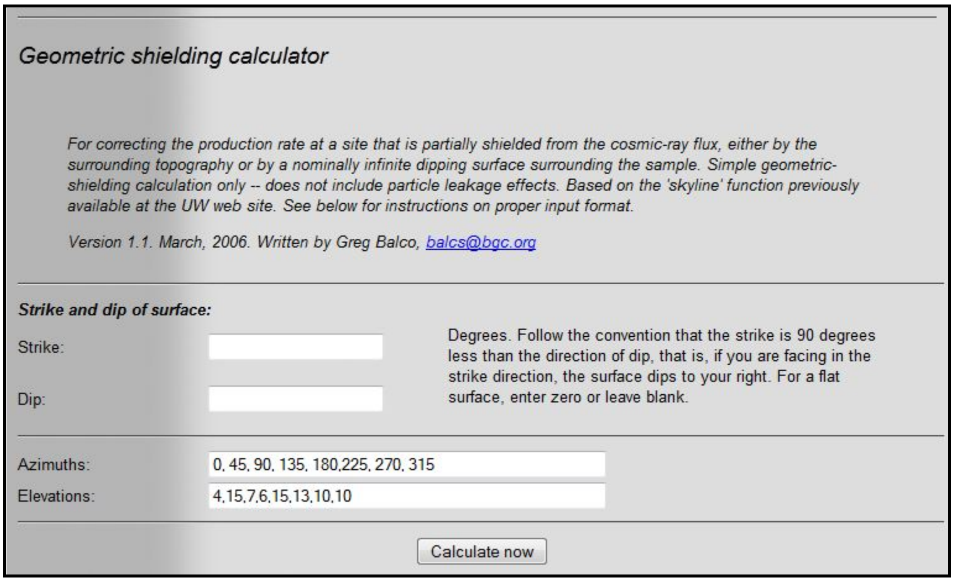


Figure 16. Calculation sample's correct azimuth angles. A screenshot from website (http://hess.ess.washington.edu/math/general/skyline_input.php, 2013)

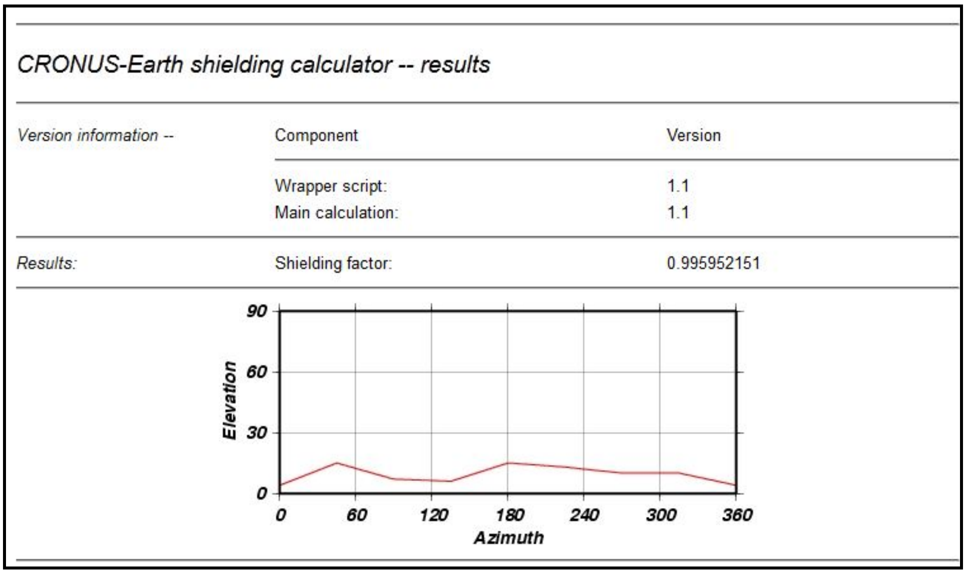


Figure 17. Calculation result of the sample's corrected azimuth angles.A screenshot from website (http://hess.ess.washington.edu/math/general/skyline_input.php, 2013)

2.1.1. Geomorphologic mapping of glaciated mountains

2.1.1.1. Glacial landforms

2.1.1.1.1. Glaciers

"Glaciers are ice masses with special characteristics that move with their own flow patterns under the influence of the force of gravity, but show physical differences from the stable snow blankets located at high mountains and from solid state of water known as ice, and are formed by re-crystallization" (Turoğlu, 2011).

"Glaciers are ice masses that do not melt either in summer or winter in polar region and high mountains and move under the effect of the force of gravity. They are formed by the increase in the pressure of snow masses that accumulate over time and by transforming them into ice" (Çiner, 2012).

2.1.1.1.2. Erosion patterns formed by glaciers

Glacier patterns develop as a result of the interaction between the factors such as lithology, processes, agents, structure and time. Glaciers also perform the process of great erosion. However, the effectiveness of glaciers' erosion depends on the nature of the lithology. Another important point is the time that controls the severity of the situation. The longer the time passes the more change and development of shapes increase. Glacier erosion patterns are divided into groups as small erosional features and large erosion forms (Turoğlu, 2011).

2.1.1.1.3. Small erosional features

These are glacial erosion forms which are smaller than one meter in dimension. These erosion forms are notches, runnels and scratches with depth of a few millimeters or a few or ten centimeters in sizes (Turoğlu, 2011).

2.1.1.1.4. Glacier scratches

Glacier scratches are eroded linear features that are formed by the friction of the rocks in different sizes to the bedrock due to pressure caused by the movement of glacier masses (Turoğlu, 2011).

2.1.1.1.5. Large erosion forms

These are erosional forms that are formed on the bedrock by glaciers and are expressed by tens of meters in sizes, or, even in kilometers. As being accumulation zone of Alpine-type mountains glaciers, they primarily play an active role on eroison (Turoğlu, 2011)

2.1.1.1.6. Cirque

Cirque formation is located on firn part where accumulated glaciers are formed. It is considered to be the area in which the first glaciations began. They are dish-shaped areas that are covered with sharp and semi-circular facets.

2.1.1.1.7. Transportation methods of glaciers

Glaciers can cause the transportation of materials in different sizes, shapes, volume and masses to long distances. Transportation of glaciers shows variations due to the weight and movement of the glacier. Glaciers, during transportation, carry all the materials that are found under, over or inside them. Materials, taken in during the transportation of glaciers, consist of materials that are generally loose, disintegrated and easily-torn. Melting and freezing occur in glaciers due to change of temperature in time. Hence, materials, disintegrated from bedrock, can emerge and, for this reason, glaciers can cause these materials to be taking in easily and to be carried during the transportation (Turoğlu, 2011).

2.1.1.1.8. Glacial accumulation forms

The bedrock fragments and small-pieced materials of different sizes create the load by the transportation of glaciers. These transported materials, by the withdrawal and melting of glaciers, are accumulate in various places. These accumulated materials create different forms of storage by accumulating in the base, front or around of glacial bed. These accumulation forms are divided into two different groups. These two groups differ as materials stored by the effect of glacier directly or indirectly (Turoğlu, 2011).

2.1.1.1.9. Non-stratified accumulation forms

Moraine glacial accumulation forms are glacial accumulation forms commonly seen in mountain glaciers as well as in sheet glacier. Moraines, one of the glacial accumulation forms, are divided into different forms by showing differences in terms of formation and format.

Lateral moraines are formed by valley glaciers. Lateral moraine is defined as linear-shaped morphologies that stretch parallel to the glacial in the direction of two-slopes of the glacial valley (Turoğlu, 2011) (Figure 18).

Medial moraines, like lateral moraines, are characteristic accumulation shapes of valley glaciers (Turoğlu, 2011). Medial moraine is the combination of two glacial formations in order to take shape of the glacier. It is formed between two moraines.

End moraines are formed either in the front parts or in the façade part of the glacial tongue. These moraines present an image similar to the shape of an arc. End moraines joins with lateral and ground moraines.

Ground moraines are formed as a result of the accumulation of materials coming from glacier base in a way to create a cover at the bottom during further or backward movement of glaciers. They mix with ablation moraines due to the retreat of glaciers (Turoğlu, 2011).

Ablation moraines are formed as a result of the ablation of glacier on the ground moraines and can be mixed with ground moraines (Turoğlu, 2011).

Figure 18. Lateral moraine image from the Kuruova valley

2.1.1.2. Mapping

Various maps are used in the field. A variety of data were used while creating maps. These data are vector and raster data types. While drawing maps in vector data, maps are drawn under three groups such as point, line and polygon. DEM (Digital Elevation Model) and satellite images are used while drawing maps using raster data.

While some of the maps used in the research area were ready-made, others are prepared with the aim of using in the field. Topographic maps are readily-used. The remaining maps were prepared to be used in the field (Figure 19-20-21).

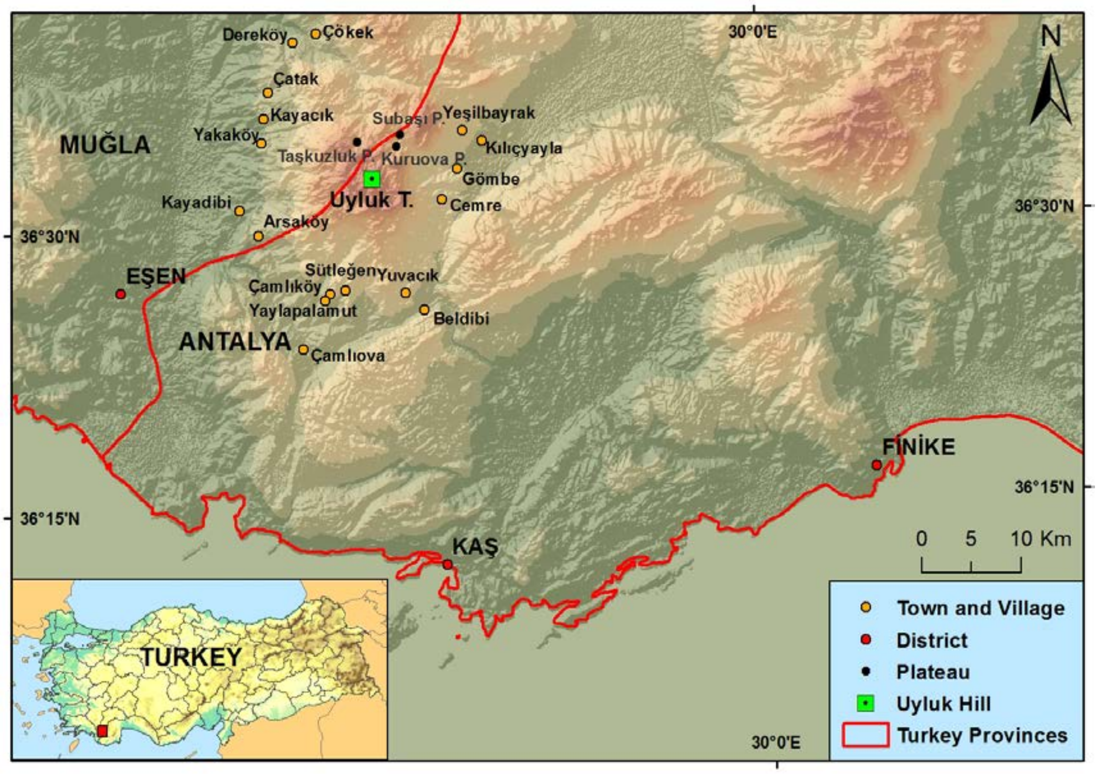


Figure 19. Settlement map of the study area

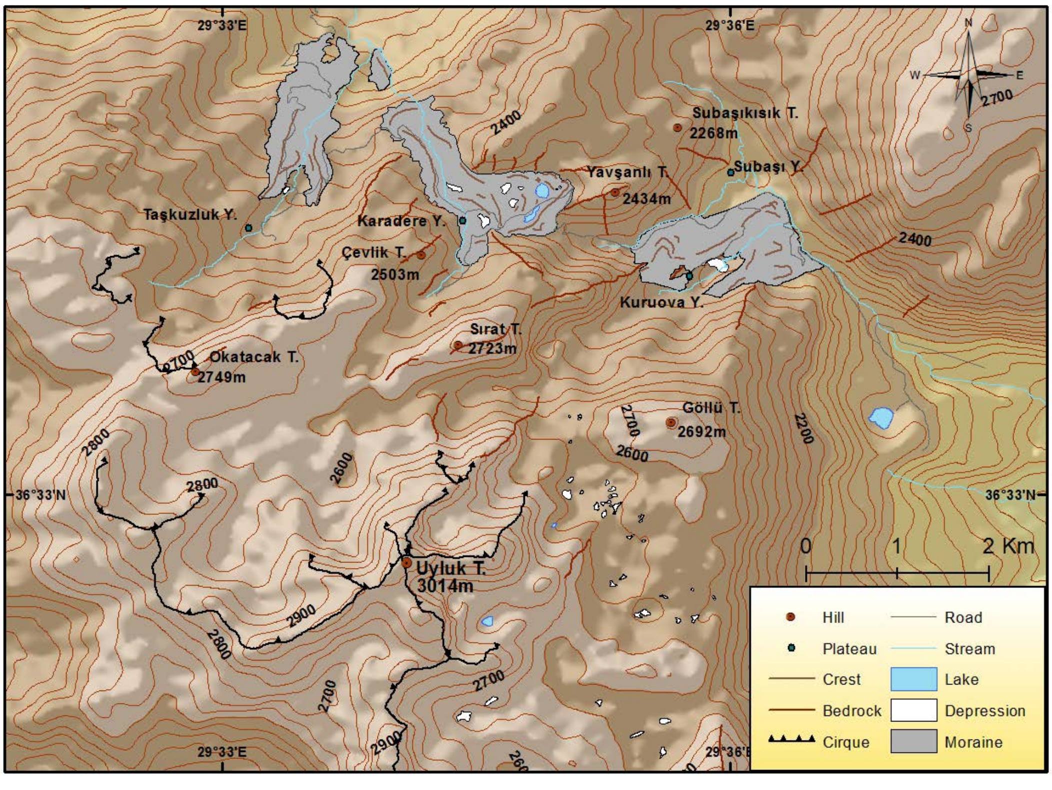


Figure 20. Topographic map of the study area

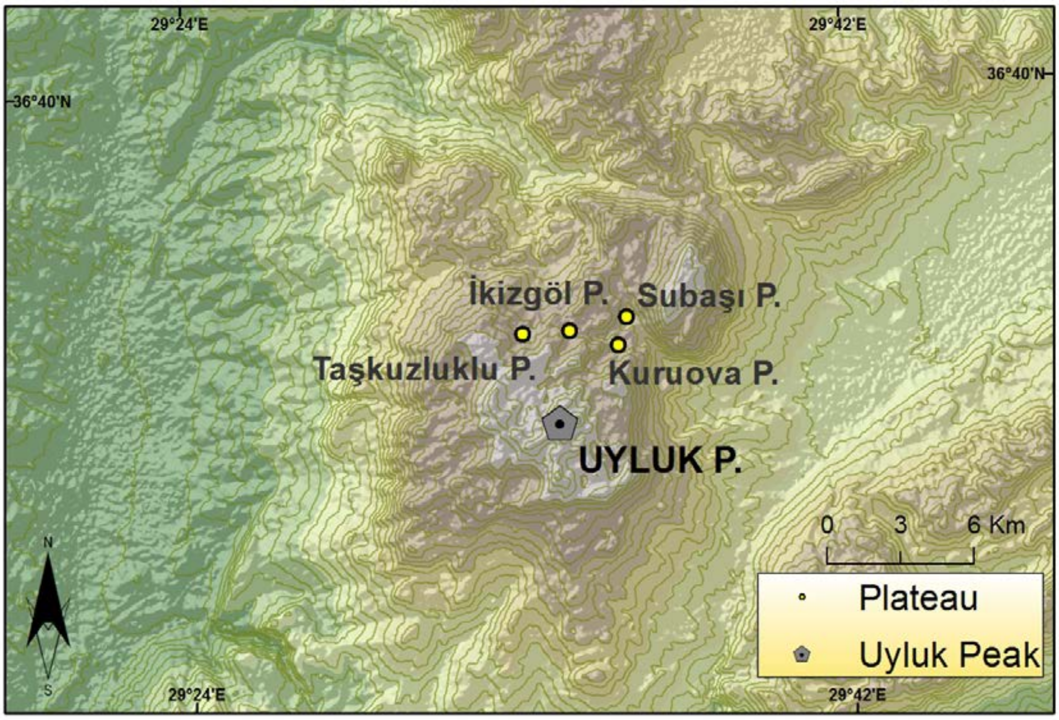


Figure 21. Yayla map of the study area

2.1.2. Sampling for cosmogenic analysis

Sampled rocks are taken from moraine ridges, making sure that the root of rock block is in the matrix. Sample weight is taken as approximately five-hundred grams, noting that rock blocks were not overturned and in straight position (Figure 22).

Figure 22. An image taken from sample boulder (AK11-618, 30.06.2011)

Key points that are needed to be complied after taking samples are as follows: the coordinates and elevation of the rock block, from which the sample is taken, are determined and noted, azimuth angles are taken in 45° angles by inclinometer and noted, rock samples are numbered and recorded, photograph of the rock, where sample is obtained, is taken and photograph numbers are noted, the sketch of moraine, where sample is obtained, is drawn and, finally, samples are put inside samples bags after writing their names and serial numbers on the sample bag (Figure 23).

Figure 23. An image taken from sample boulder (AK11-638, 01.07.2011)

2.2. Cosmogenic exposure dating

Cosmogenic exposure dating method aims to identify how long any rock or sediment was open to the influence of cosmic radiation (Çiner et al. 2003). It is well-known that the stable and radioactive nuclides (isotopes) are formed as a result of the interaction between cosmic radiation (neutron and muon flux) reaching atmosphere and mineral atoms that form rocks (Davis and Schaffer, 1955; Lal, 1988). Cosmic radiation, reaching the earth from outer space, forms radioactive nuclides and causes accumulation by reaching the uncovered surfaces of rocks and by affecting minerals or elements of the atoms that form these rocks. The cosmic radiations of ^{3}He, ^{10}Be, ^{14}C, ^{21}Ne, ^{26}Al, ^{36}Cl are cosmogenic isotopes that are formed in the body of rocks with cosmic ray bombardment. The amount of these isotopes is proportional with the time of rocks' exposure to the cosmic radiation and the time of formation, extinction and production rates of each isotope. In cosmogenic isotope analysis, the measurement of isotope formation, such as ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl is carried out by accelerator mass spectrometry (AMS). The time of rocks' exposure to cosmic radiation is calculated by using these data. This method is widely used for the tasks such as determining the ages of accumulation and erosion forms performed by different factors and processes. Acceleration and rates of erosion, dating of lava flows, fault age and the frequency of tectonic movements can be performed (Martini et al. 2001; Sarıkaya et al. 2008).

Ages of moraine deposits and erosion rates occurring on the materials are determined from the concentration measurements of ^{10}Be and ^{26}Al performed on moraine deposits and erratic blocks (Kaplan et al. 2005). Zreda and Phillips (1995) determined the exposure age of the Late Pleistocene moraines in the study they conducted using cosmogenic ^{36}Cl method. In addition, glaciations chronology, distribution areas, development phases and movements of glaciations are also determined with dates obtained from different locations of the same region by using this technique. In another research, ^{10}Be and ^{26}Al cosmogenic dating, applied on moraines belonging to cirque glaciations located in high altitudes, are used in determining the glaciations chronology, glaciations limits and glaciations fluctuations (Zreda et al. 1994; Matthews et al. 2008; Shakesby et al. 2008). Glaciers react very sensitive to changes in climate. Even a temperature change of $1^{\circ}C$ can trigger the regression of glaciers. In the event of glaciers' withdrawal, moraines, which remain in embedded state inside glaciers, are surfaced and become open to cosmic radiation. This event starts the chemical reactions that cause the formation of Be^{10} isotope on the surface of moraine. How long this moraine is exposed to cosmic radiation is determined by counting this newly-formed radioactive isotope. The age is the date in which glacier deposited moraine while glaciers withdraw.

Cosmogenic isotope analysis methods are also frequently used in geomorphologic applications such as the accumulation forms of volcanic environments, earth deformations caused by earthquakes, rapid mass movements, rapid erosions caused by waves and rivers on the bedrock, glacier erosions such as striated, gullied polished surfaces on the bedrock caused by the retreat of glaciers, surfacing of covered sediment or glaciers, meteorite impacts and its effects for the last ten years. With this technique, dating and developmental stages of geomorphologic events or units, the frequency of change are determined between the time interval of a few years or a few million years (Bierman, 1994; Cockburn and Summerfield, 2004).

In addition, cosmogenic dating can be conducted with the measurement of ^{36}Cl accumulation, occurring in volcanic materials such as lava and tephra. It is possible to determine, by using this method, the development of volcanic activities by defining the ages of volcanism which occurred intermittently at the same volcanic center and volcanic products which were exposed to cosmic rays at different times (Zreda et al. 1993).

Cosmogenic ^{36}Cl technique is also used to determine the historical earthquakes that occur periodically. With these method applied on the fault escarpments formed by these earthquakes, the history of each tectonic movements, causing earthquakes, are determined (Zreda and Noller, 1998).

Contary to ^{14}C age determination method widely used before, isotopes, belonging to various elements, can be used with cosmogenic methods. Despite the obligation of including certain minerals inside the rock for isotopes such as ^{26}Al and ^{10}Be, almost all rocks contain ^{36}Cl isotope. Another advantage of this method is the good level of its analytic measurement quality.

The most commonly used field of this above-mentioned method is the determination of the stages of glacial progression through the specification of surfaces eroded by glaciers and the surfacing times of blocks located inside moraines (Phillips et al. 1990; Zreda et al. 1994, 1999; Zreda and Phillips, 1995; Steig et al. 1998). In these studies that are important in terms of paleo-climate, sampling requires a special technique and attention. Samples were obtained from various parts of Turkey as part of this study. These samples were taken from Akdağ, Geyik Mountain and Erciyes Mountain. These samples were collected from the known lava flows over which glacier passes, and the largest size and the broadest blocks located at the highest possible points of moraine ridges. Here the goal is to ensure as far as possible the stability and non-relocation of the blocks, found on the moraine barriers that were formed while glaciers were withdrawing, after surfacing and thus, the measureable age exactly reflects the time of glacial withdrawal. A total of samples with weight of 0,5-1 kg, taken from the highest top part, with the size of 1-3 cm, of relatively flat and non-eroded blocks of each moraine barriers, were prepared for grinding in order to conduct analysis later on.

In addition, the mapping of these moraines was also carried out while taking these samples. In this context, these places, which were determined with the help of satellite images earlier, were transferred into maps later on with the help of handheld GPS and following the moraine ridges. In this way, the distribution, location of moraines and what sort of expansion they show could be detected.

2.2.1. Laboratory methods

2.2.1.1. Crushing-Grinding-Sieving

2.2.1.1.1. Process Stages of Crushing-Grinding-Sieving

There are several steps to preparing samples to wet chemistry (Figure 24).

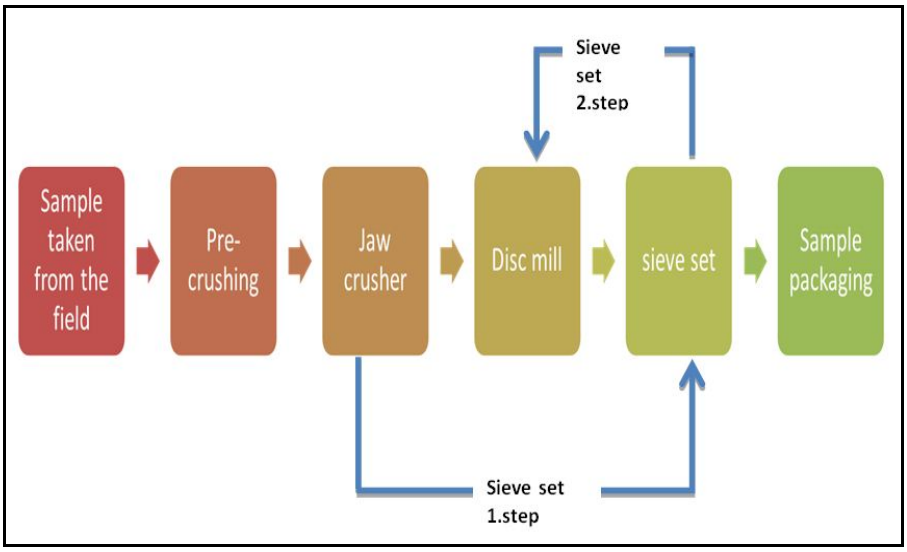


Figure 24. Steps of crushing-grinding-sieving

2.2.1.1.1.1. Preparation of the samples for the process of crushing

Samples, collected from the field, are brought to the crushing-grinding-sieving laboratory in a packaged form. Firstly, sample is weighed and its weight is recorded. Packages are opened and samples are placed in a clean container. The goal of this stage is to prepare samples before breaking them into pieces in the crusher (Figure 25).

Figure 25. Boulder sample

2.2.1.1.1.2. Jawed-crusher

In the second stage, rock samples, obtained from the field, are broken into grain size in the range of 1-15 mm in the jawed-crusher. While performing this process, rock samples are emptied from top chamber of the device after being ground and the ground-rock fragments are taken from the collection box located at the bottom of the machine. The goal of this stage is to bring the sizes of hand-samples, taken from the field, to a size suitable for the disc mill (Figure 26).

Figure 26. Jaw crusher

2.2.1.1.1.3. Sieve set 1st stage

Sieve set is prepared, from bottom to top, in the order of collection container, 0.25 mm, and 1.0 mm. Rocks, crushed in the disc mill, are poured into sieve set and sieving process is done manually. Fragments, over the size of 1 mm, are emptied into the disc mill. The goal of this stage is to bring the loss down to minimum occurring in the disc mill (Figure 27).

Figure 27. Sieve set

2.2.1.1.1.4. Disc mill

The distance between the discs in the device is set to 1 mm. Loss and gain rates are ensured by arranging the optimum distance between the discs. At this stage, the grain size of the rocks is further reduced (Figure 28).

Figure 28. Disc mill

2.2.1.1.1.5. Sieve set 2nd stage

In this stage, rock fragments, ground in disc mill, are emptied into sieves. The goal of this stage is to separate fragments in the range of above 1 mm and 0.25 mm. Fragments with the size of under 0.25 mm will not be used in analysis. If any fragment over 1 mm remains, they are crushed in disc mill again and are sieving. After putting rock fragments into the sieves, device is set to grind for 15 minutes. The goal of this stage is to separate samples fragments between 1 mm and 0.25 mm (Figure 29).

Figure 29. Sieve set

2.2.1.1.1.6. Final sieving

After grinder finished its process, small dust is emptied from 0.25 mm, which is the bottom of sieves, to the collection container (Figure 30).

Figure 30. Powder container

Another stage after sieving in the grinder is the bagging process of rock samples that are left between 0.25 mm and 1 mm. In the bagging process, sample number as well as 0.25mm-1mm unleached is written on the bag. The goal of this stage is not mixing the samples and is storing them in clean-dry conditions (Figure 31).

Figure 31. 0.25-1mm sample packed

2.2.1.1.1.7. Cleaning

This stage is the first part of cleaning process. Cleaning process should be performed after each sample is finished, because each sample should not be mixed with each other. In this process, jaw-crusher is cleaned with a brush starting from an upper chamber. In addition, dusts are squirted by air squirting machine and this is to be repeated in every process (Figure 32).

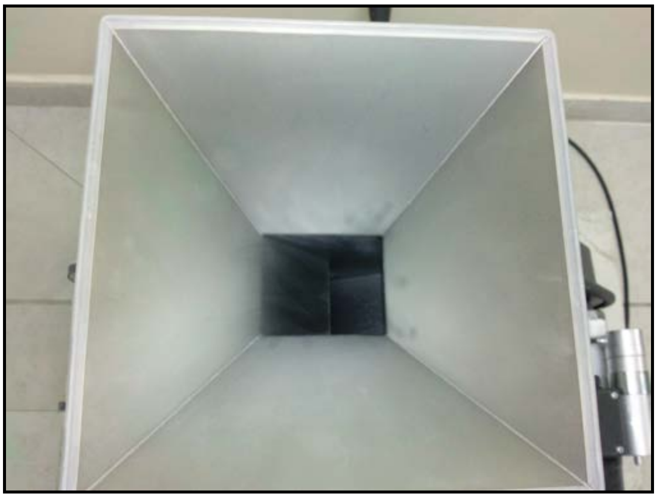


Figure 32. Cleaning jaw crusher

In the continuation of cleaning process, jaw is removed from the jaw-crusher and is cleaned with a wire brush (Figure 33).

Figure 33. Cleaning parts of the jaw crusher

In the next process, the cleaning of jawed-crusher's fixed jaw and crusher's interior is continued. Wire brush, paint brush and vacuum cleaner are used while cleaning. In the continuation of this stage, bottom part of the crusher and box, which located at the bottom part of the crusher and to which samples are poured as a result of the process, are cleaned. At the end of the stage, sides of the device are carefully cleaned (Figure 34).

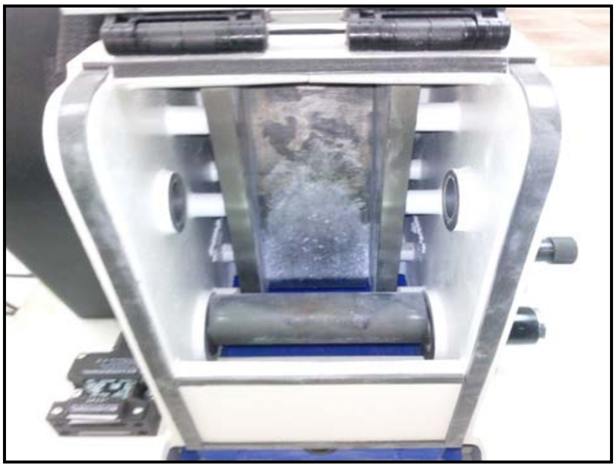


Figure 34. Cleaning jaw crusher

In the continuation of cleaning process disc mill is cleaned. Like in jawed-crusher, it is cleaned starting from the top chamber to which samples are poured. After cleaning the top chamber, disc cover is opened and it is cleaned by wire and paint brushes. At the end of this stage, the chamber, to which samples are poured, and the counter, where device is located at, are cleaned (Figure 35).

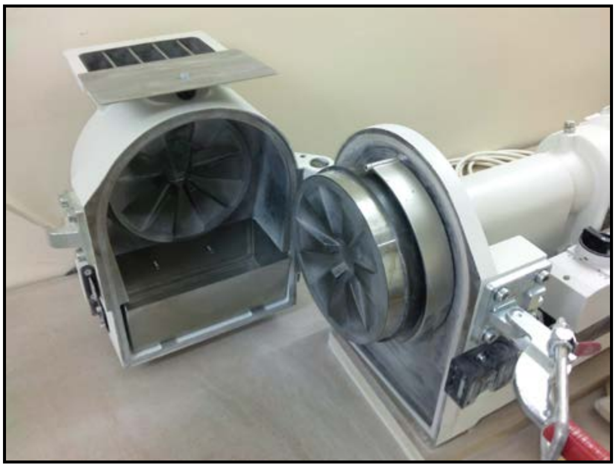


Figure 35. Cleaning disc mill

In this process, sieves, crusher and counter, where the device is located, are cleaned and they are rendered ready for the next sample. Paint brush and wire brush are made use of while cleaning the sieves (Figure 36).

Figure 36. Cleaning sieve set

In the process of recording, the finished samples are recorded by writing information on process date and process stages. The last process is the weighing of the last state of sample is carried out just like the weighing of samples in the first stage (Figure 37).

Figure 37. Taking note

2.2.1.1.1.8. Additional-disc mill

The fragments of over 1 mm, which are detained in the sieving set, are ground in order to bring them down to 1-12 mm in the disc mill. The disc distance was in the space of 0.30 mm while setting the disc distance of the device, but it expanded to the distance of 0.60 mm at the end of the process. As a result of this expansion, the rate of loss showed a linear decrease. The goal of this stage is to ensure the fragmentation of rock fragments between 0.25 mm and 1 mm by reducing them further. The loss rates of this expansion are shown in the following graph (Figure 38).

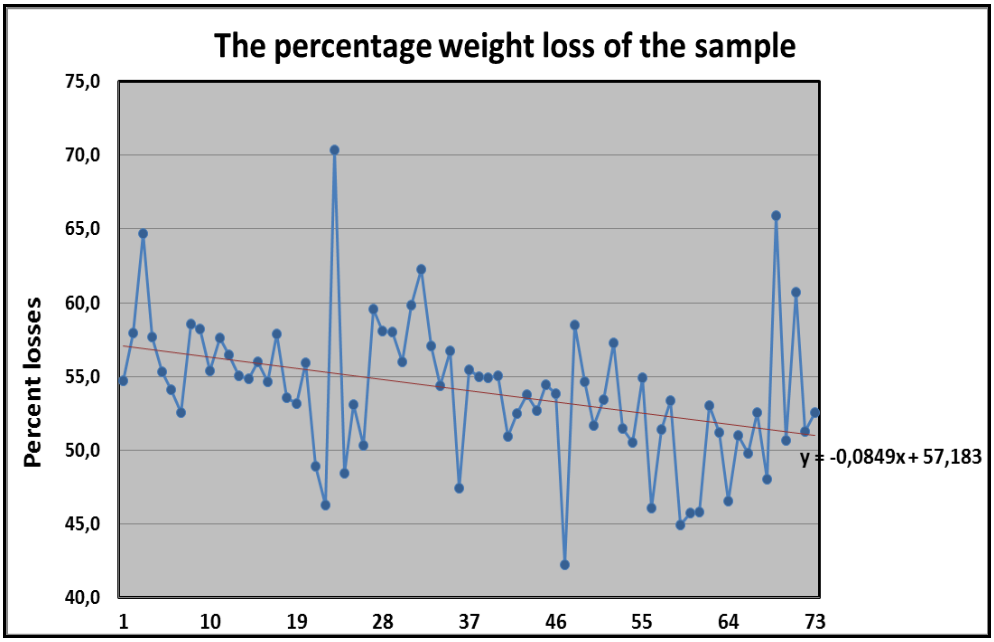


Figure 38. Graph showing the percentage of the sample weight loss

When looking at the graph, a general decrease is seen while going from the first sample to seventy-third sample. The cause of this is due to the gradual expansion of the distance between the discs of the disc mill.

2.2.1.2. Wet chemistry and extraction

In this process, the weights of Nalgene brand bottles, which are wide-mouthed and with HDPE 500 ml, were measured with a scale that shows one tenth of a gram. After measuring their weights, they were washed with Milli Q water in the next stage. After being washed by Milli Q water, the wide-mouthed and HDPE 500 mm bottles were kept in the period of 24 hours the thermo oven after bringing it at 80°C.

After keeping them in the period of 24 hours, the weights of wide-mouthed and HDPE 500 ml of bottles were measured again (Table 5).

Table 5. 500ml HDPE bottles weights

	1	**2**
Before	56.7	56.7
After	56.7	56.6
	3	**4**
Before	57.8	56.6
After	57.8	56.6
	5	**6**
Before	56.6	56.7
After	56.5	56.6
	7	**8**
Before	57.4	57.8
After	57.3	57.7

As seen in the graph, no change was seen in the wide-mouthed bottles with numbers one, three and four. But, change was witnessed in the wide-mouthed bottle with numbers two, five, seven and eight.

2.2.1.2.1. Leaching

Before leaching ground samples with acid, it is necessary to determine what type of the rock it is. The reason for this is that different leaching methods will be applied to samples. 5% of HNO_3 is poured on the samples in order to understand whether they are carbonate or silicate. The goal in these two processes is to clean the samples obtained (Sarıkaya, 2009) (Figure 39).

Figure 39. Sample and Nitric Acid

2.2.1.2.1.1. Leaching carbonates

Leaching process consists of two phases. In the first phase, samples are leached with MilliQ and in the second phase, 10% HNO_3 is poured on the samples. The goal in these two processes is to clean the samples obtained (Figure 40) (Table 6).

Figure 40. Photo of the MilliQ

Table 6. Leaching with milliQ and 10% HNO_3

A. Leaching with milliQ	A.1	Label and weigh empty 500 ml HDPE bottle with cap [g]
	A.2	Tare & add ~50 g sample. Record weight [g]
	A.3	Add ~8 ml milliQ/g sample (~400 ml milliQ per bottle)
	A.4	Shake 2 h @ speed: 230 rpm (set:6)
	A.5	Discard solution and rinse 1x with milliQ
	A.6	Repeat A.3-A.5 two more times
	A.7	Dry overnight @ 80°C
	A.8	Weigh bottle with cap [g] + sample [g]
	A.9	Calculate sample's weight [g] after leaching with milliQ
	A.10	Calculate weight lost (%)
B. Leaching with 10% HNO_3 Aliquot for ICP-MS	B.1	Add ~1 ml milliQ/g sample (estimate from A.9)
	B.2	Add ~1 ml 10% HNO_3/g sample (estimate from A.9)
	B.3	Rest overnight with sample bottle capped
	B.4	Rinse 3x with milliQ
	B.5	Dry onernight @ 80°C
	B.6	Weigh bottle with cap [g] + sample [g]
	B.7	Calculate sample's weight [g] after 10% HNO_3 dissolution
	B.8	Calculate total weight lost (%)
	B.9	Take ~5 g aliquot to powder for ICP-MS
	B.10	Calculate the remaining sample's weight [g]

The third phase is the process of pulverizing the leached sample after the first two phases. The goal in this phase is to get samples ready for ICP-MS measurements (Figure 41) (Table 7).

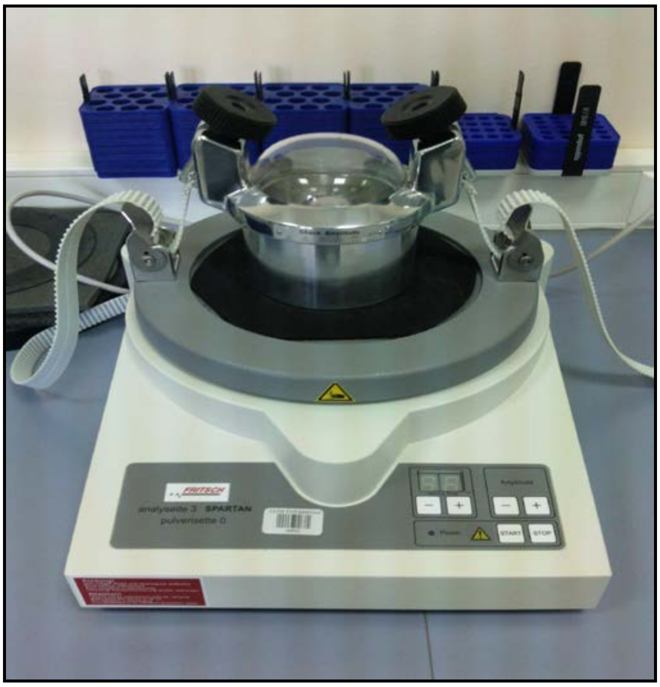


Figure 41. Photo of the vibratory machine

Table 7. Powdering

C. Powdering	C.1	Place the rubber liner and steel mortar onto the vibratory
	C.2	Add the aliquot sample and place the steel ball into the mortar
	C.3	Put on the cover glass top and secure the toothed belt system
	C.4	Run the machine @ 1mm aplitude dor 5 min
	C.5	Transfer powdered sample into a clean&labeled glass vial
	C.6	Rinse all equipments with milliQ & 5% HNO_3 and dry

The process in this phase is to put spike solution inside the samples. In the natural environment, there are three kinds of chlorine isotopes. While ^{35}Cl and ^{37}Cl isotopes are fixed, ^{36}Cl isotope is radioactive. While measuring with AMS, R/S ratio is calculated. For this purpose, spike solution is put inside samples (Figure 42) (Table 8).

Figure 42. General view from the laboratory

Table 8. Spiking and total dissolution

D. Spiking and total dissolution	D.1	Name of the spike solution
	D.2	Concentration of the spike solution [mg/g]; [mg^{35,37}Cl/g solution]
	D.3	^{35}Cl/^{37}Cl ratio of the spike solution [-]
	D.4	Weigh ~1 g spike solution into the sample bottle with micropipette
	D.5	Add ~40 ml milliQ
	D.6	Add 10 ml 0.1 M $AgNO_3$
	D.7	Add ~10 ml 10% HNO_3/g sample (gradually in 20 min) (calculate from B.10)
	D.8	Maintain bottle cap loosed
	D.9	Do D.1-D.7 for the blank(s), too.

The goal of this phase is to ensure subsidence of sediments and to draw up chlorine (Figure 43) (Table 9).

Figure 43. Photo of the decanting acids

Table 9. Chlorine extraction

E. Chlorine extraction	E.1	Decant acid as much as you can without disturbing the sediment
	E.2	Transfer solution into a labeled new 50 ml centrifuge tube
	E.3	Centrifuge 15 min @ speed: 3000 rpm
	E.4	Decan acid, keep sediment & repeat until nothing left in the bottle

The goal in this process is to ensure the subsidence of $BaSO_4$ from other chemicals by adding 25% of NH_4OH, $Ba(NO_3)_2$, and 65% of HNO_3 (Figure 44) (Table 10).

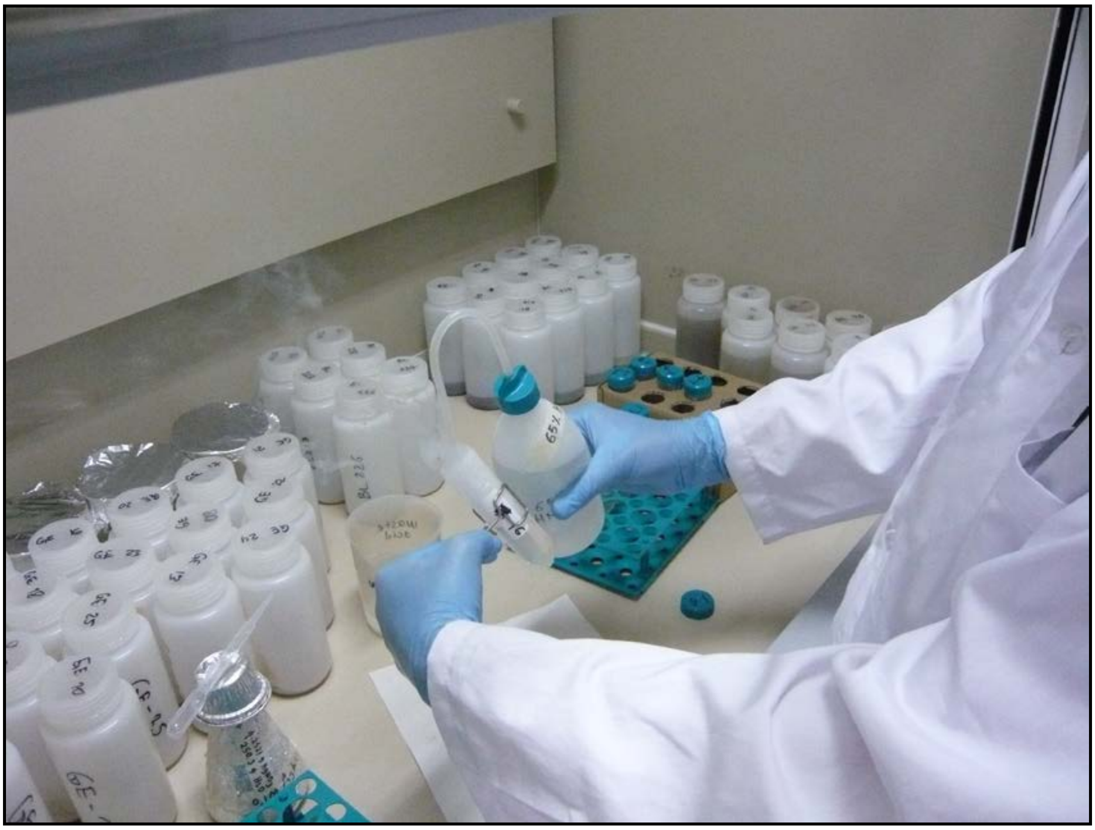


Figure 44. Adding 65% HNO_3

Table 10. $BaSO_4$ precip

F. $BaSO_4$ precip	F.1	Add 5 ml of 25% NH_4OH to dissolve AgCl
	F.2	Add 1 ml saturated $Ba(NO_3)_2$ solution to precipitate $BaSO_4$
	F.3	Let stand overnight
	F.4	Centrifuge 15 min @ speed: 3000 rpm
	F.5	Transfer liquid to a labeled new 15 ml centrifuge tube
	F.6	Acidify with concentrated 65% HNO_3 until you see white precipitate of AgCl
	F.7	Add 1 ml 0.1 M $AgNO_3$ (Just squirt in)
	F.8	Let stand overnight in a dark place

The goal in the final phase is to get samples ready for AMS measurements (Figure 45) (Table 11).

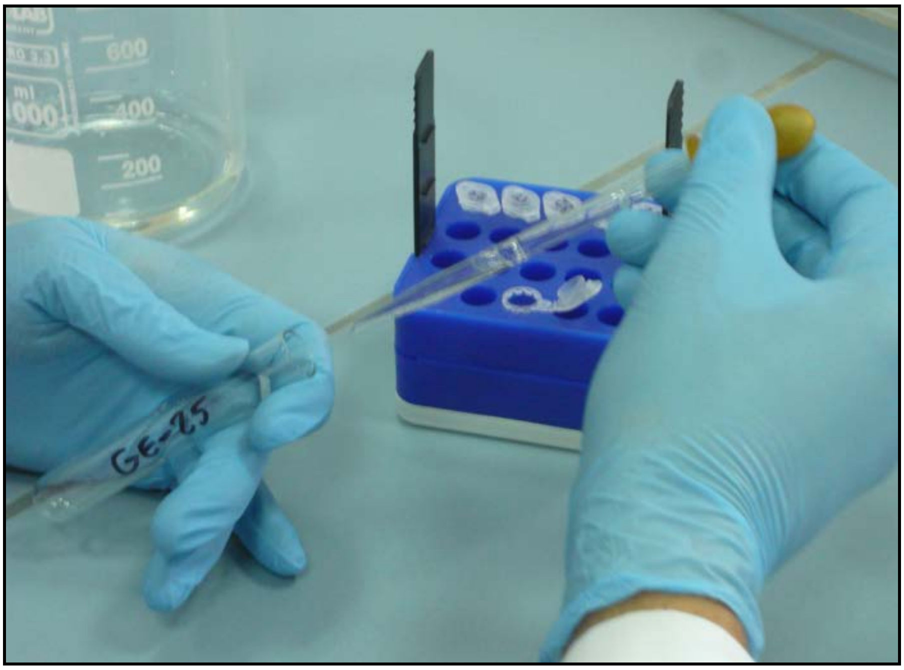


Figure 45. Preparing samples to AMS

Table 11. Final target preperation

G. Final target preperation	G.1	Decant acid. Keep sediment
	G.2	Rinse sediment in milliQ 5x. Use new glass pasteur pipette for each sample
	G.3	Label and weigh a clean teflon vial [g]
	G.4	Transfer well rinsed AgCl into a teflon vial using the sample pipette
	G.5	Centrifuge 15 min @ speed: 3000 rpm
	G.6	Remove excess water tap the vial
	G.7	Dry 24 h @ 60°C
	G.8	Weigh dried vial + sample [g]
	G.9	Calculate the weight of final AgCl target [mg]
	G.10	Cap the vial and store them in a dark & dry place. Record the date & person

2.2.1.2.1.2. Leaching silicates

The first process of leach phase takes place differently than carbonates. In the first process of silicates, samples are cleaned by pouring 10% of HNO_3 before leaching them with MilliQ (Figure 46) (Table 12).

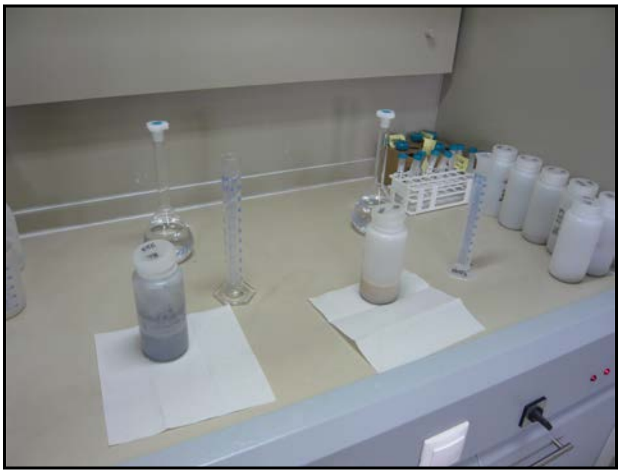


Figure 46. Adding ~50ml 10% HNO_3

Table 12. Leaching with 10% HNO_3 Aliquot for ICP-MS

A. Leaching with 10% HNO_3 Aliquot for ICP-MS	A.1	Label and weigh a beaker [g]
	A.2	Tare & add ~50 g sample. Record weight [g]
	A.3	Add ~50ml milliQ [g]
	A.4	Add ~50ml 10% HNO_3
	A.5	Cover with aluminum folio, and rest overnight
	A.6	Discard solution and rinse sample 3x with milliQ
	A.7	Dry overnight @ 80°C
	A.8	Weigh beaker [g] + sample [g]
	A.9	Calculate sample's weight [g] after 10% HNO_3 dissolution
	A.10	Calculate total weight lost (%)
	A.11	Take ~5 g aliquot to powder for ICP-MS
	A.12	Calculate the remaining sample's weight [g]

In the second phase, the process is to pulverize samples that were cleaned in the first phase. The goal in this phase is to get samples ready for ICP-MS measurements (Figure 47) (Table 13).

Figure 47. Preparing samples to ICP-MS

Table 13. Powdering

B. Powdering	B.1	Place the rubber liner and steel mortar onto the vibratory
	B.2	Add the aliquot sample and place the steel ball into the mortar
	B.3	Put on the cover glass top and secure the toolhed belt system
	B.4	Run the machine @ 1 mm amplitude for 5 min
	B.5	Transfer powdered sample into a clean & labeled glass vial
	B.6	Rinse all equipments with milliQ & 5% HNO_3 and dry

The process in this phase is to put spike solution inside the samples. In the natural environment, there are three kinds of chlorine isotopes. While ^{35}Cl and ^{37}Cl isotopes are fixed, ^{36}Cl isotope is radioactive. While measuring with AMS, R/S ratio is calculated. For this purpose, spike solution is put inside samples (Figure 48) (Table 14).

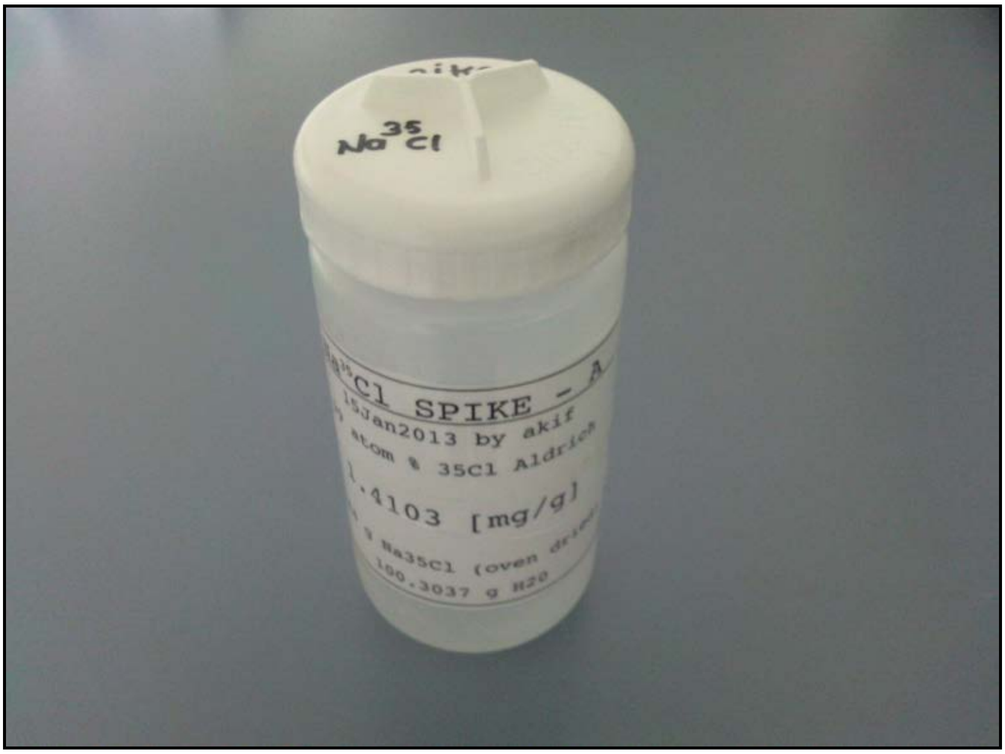


Figure 48. Spike solution

Table 14. Spiking and total dissolution

C. Spiking and total dissolution	C.1	Name of the spike solution
	C.2	Concentration of the spike solution [mg/g]; [mg^{35,37}Cl/g solution]
	C.3	$^{35Cl/C37}$Cl ratio of the spike solution [-]
	C.4	Weigh ~10 g sample to the PTFE cup [g]
	C.5	Weigh ~1 g spike solution in the PTFE cup [g]
	C.6	Move under the hood, and ~5 ml 65% HNO3
	C.7	Add ~40 ml 40% HF
	C.8	Assamble the bomb, and place in the oven at 130°C for 6 hours
	C.9	Do C.1-C.8 for the blank(s), too. Except C.4!

The goal of this phase is to ensure subsidence of sediments and to draw up chlorine (Figure 49) (Table 15).

Figure 49. Silver Nitrate

Table 15. Chlorine extraction

D. Chlorine extraction	D.1	Add 10 ml 0.1 M $AgNO_3$
	D.2	Let stand overnight
	D.3	Decant acid as much as you can without disturbing the sediment
	D.4	Transfer solution into a labeled 50 ml centrifuge tube
	D.5	Centrifuge 15 min @ speed 3000 rpm
	D.6	Discard acid, keep sediment & repeat until nothing left in the PTFE cup

The goal in this process is to ensure the subsidence of $BaSO_4$ from other chemicals by adding 25% of NH_4OH + $Ba(NO_3)_2$. This process is repeated three times differing from carbonates (Figure 50) (Table 16).

Figure 50. Adding 65% HNO_3

Table 16. BaSO4 precipitations

E. First BaSO4 precipitation	E.1	Add 5 ml of 25% NH_4OH to dissolve AgCl, and vortex
	E.2	Add 1 ml oversaturated $Ba(NO_3)_2$ solution to prepitate $BaSO_4$
	E.3	Let stand overnight
	E.4	Centrifuge 15 min @ speed 3000 rpm
	E.5	Transfer liquid to a labeled 15 ml centrifuge tube
	E.6	Acidify with concentrated 65% HNO_3 until you see White precipitate of AgCl
	E.7	Add 1 ml M $AgNO_3$ (Just squirt in)
	E.8	Let stand overnight in dark place
F. Second	F.1	Decant acid . Keep sediment
	F.2	Add 5 ml of 25% NH_4OH to dissolve AgCl, and vortex

$BaSO4$ precipitation	F.3	Add 1 ml oversaturated $Ba(NO_3)_2$ solution to prepitate $BaSO_4$
	F.4	Let stand overnight
	F.5	Centrifuge 15 min @ speed 3000 rpm
	F.6	Transfer liquid to a labeled 15 ml centrifuge tube
	F.7	Acidify with concentrated 65% HNO_3 until you see white precipitate of AgCl
	F.8	Add 1 ml 0.1 M $AgNO_3$ (Just squirt in)
	F.9	Let stand overnight in dark place
G. Third $BaSO_4$ precipitation	G.1	Decant acid. Keep sediment
	G.2	Add 5 ml of 25% NH_4OH to dissolve AgCl, and vortex
	G.3	Add 1 ml oversaturated $Ba(NO_3)_2$ solution to prepitate $BaSO_4$
	G.4	Let stand overnight
	G.5	Centrifuge 15 min @ speed 3000 rpm
	G.6	Transfer liquid to a labeled 15 ml centrifuge tube
	G.7	Acidify with concentrated 65% HNO_3 until you see white precipitate of AgCl
	G.8	Add 1 ml 0.1 M $AgNO_3$ (Just squirt in)
	G.9	Let stand overnight in dark place

The goal in this phase is to get samples ready for AMS measurements (Figure 51) (Table 17).

Figure 51. Prepared sample

Table 17. Final target preparation

H. Final target preperation	H.1	Decant acid. Keep sediment
	H.2	Rinse sediment in milliQ 5x. Use new glass pasteur pipette for each sample
	H.3	Label and weigh a clean teflon vial [g]
	H.4	Transfer well rinsed AgCl into a teflon vial using the same pipette
	H.5	Centrifuge 15 min @ speed 3000 rpm
	H.6	Remove excess water in the vial
	H.7	Dry 24 h @ 60°C
	H.8	Weigh dried vial + sample [g]
	H.9	Calculate the weight of final AgCl target [ml]
	H.10	Cap the vial and store them in a dark & dry place. Record the date & person

In the final phase, all the equipments, used in the process, are cleaned or the ones, which cannot be recycled, are destroyed using appropriate methods (Figure 52) (Table 18).

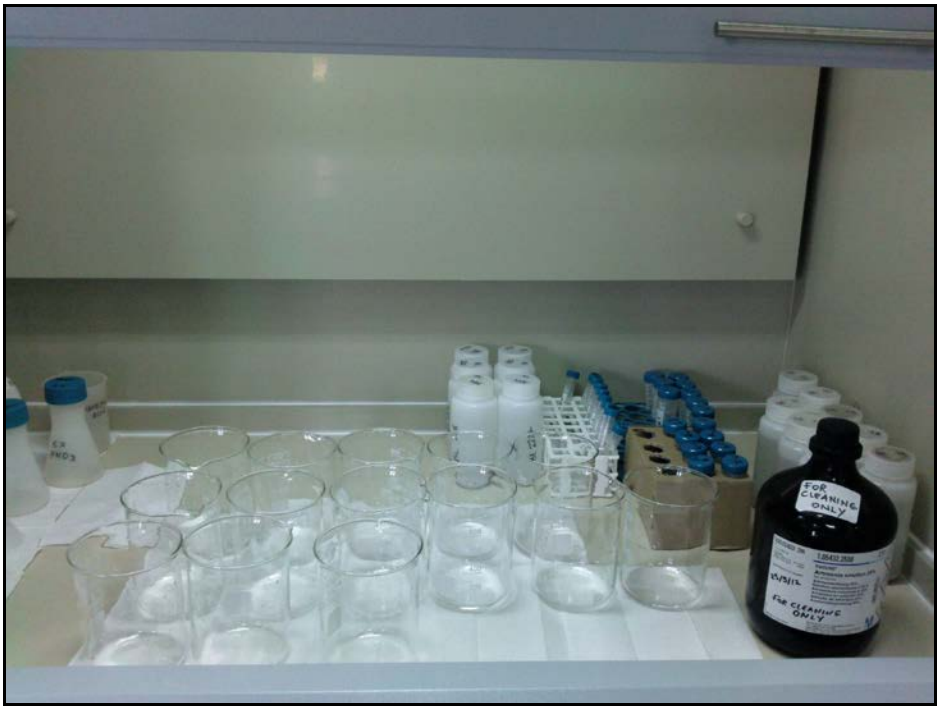


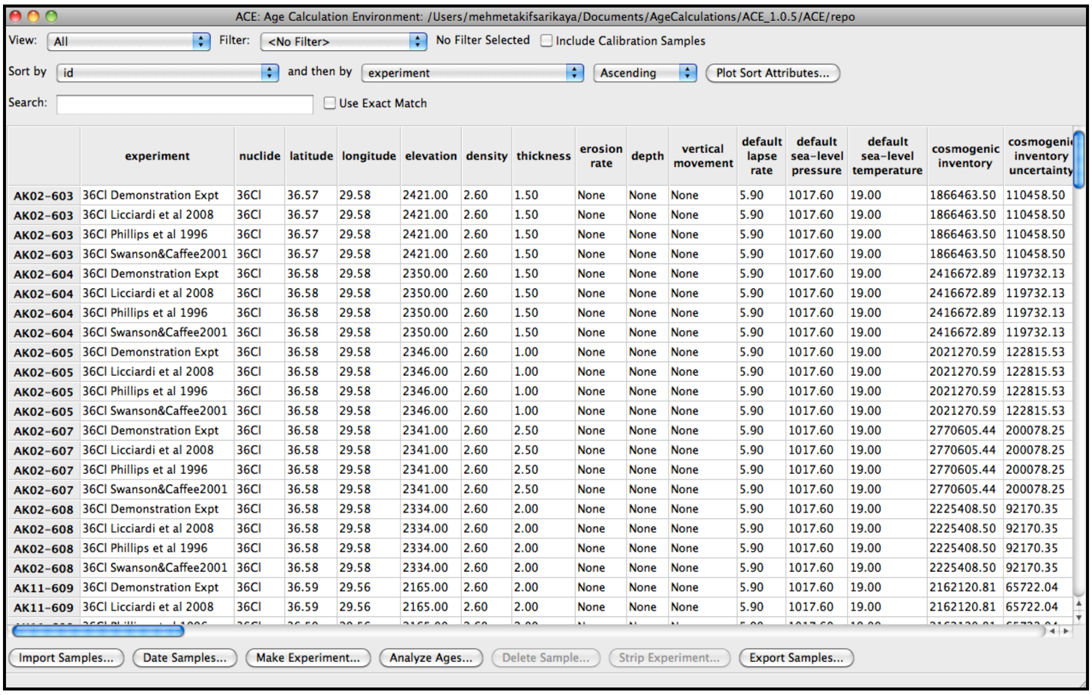
Figure 52. Cleaning equipments

Table 18. Cleaning

I. Cleaning	I.1	Discard all disposable equipments (centrifuge tubes, pipette tips, etc.)
	I.2	Wash reusable equipments (centrifuge tubes, pipette tips, etc.)
	I.3	Rinse them with (1) MilliQ, (2) 25% NH_4OH, (3) MilliQ, (4) hot 65% HNO_3
	I.4	Rinse throughly with MilliQ. Dry and store them in designated cabinets

2.2.2. Age calculations

Cosmogenic ^{36}Cl method is applied while conducting surface aging of the obtained samples. ACE (Age Calculation Engine, http://ace.hwr.arizona.edu) cosmogenic calculation software was used while applying this method (Zweck et al., 2012; Anderson et al., 2007). Data are entered into the software while calculating the ages of the surface. Data that are entered into the software are: data belonging to the samples (height, location, density, thickness, etc.), the thickness of snow remaining on the sample, topographic blocking data, and atmospheric factor data (Figure 53-54-55-56-57-58).



	experiment	nuclide	latitude	longitude	elevation	density	thickness	erosion rate	depth	vertical movement	default lapse rate	default sea-level pressure	default sea-level temperature	cosmogenic inventory	cosmogeni inventory uncertainty
AK02-603	36Cl Demonstration Expt	36Cl	36.57	29.58	2421.00	2.60	1.50	None	None	None	5.90	1017.60	19.00	1866463.50	110458.50
AK02-603	36Cl Licciardi et al 2008	36Cl	36.57	29.58	2421.00	2.60	1.50	None	None	None	5.90	1017.60	19.00	1866463.50	110458.50
AK02-603	36Cl Phillips et al 1996	36Cl	36.57	29.58	2421.00	2.60	1.50	None	None	None	5.90	1017.60	19.00	1866463.50	110458.50
AK02-603	36Cl Swanson&Caffee2001	36Cl	36.57	29.58	2421.00	2.60	1.50	None	None	None	5.90	1017.60	19.00	1866463.50	110458.50
AK02-604	36Cl Demonstration Expt	36Cl	36.58	29.58	2350.00	2.60	1.50	None	None	None	5.90	1017.60	19.00	2416672.89	119732.13
AK02-604	36Cl Licciardi et al 2008	36Cl	36.58	29.58	2350.00	2.60	1.50	None	None	None	5.90	1017.60	19.00	2416672.89	119732.13
AK02-604	36Cl Phillips et al 1996	36Cl	36.58	29.58	2350.00	2.60	1.50	None	None	None	5.90	1017.60	19.00	2416672.89	119732.13
AK02-604	36Cl Swanson&Caffee2001	36Cl	36.58	29.58	2350.00	2.60	1.50	None	None	None	5.90	1017.60	19.00	2416672.89	119732.13
AK02-605	36Cl Demonstration Expt	36Cl	36.58	29.58	2346.00	2.60	1.00	None	None	None	5.90	1017.60	19.00	2021270.59	122815.53
AK02-605	36Cl Licciardi et al 2008	36Cl	36.58	29.58	2346.00	2.60	1.00	None	None	None	5.90	1017.60	19.00	2021270.59	122815.53
AK02-605	36Cl Phillips et al 1996	36Cl	36.58	29.58	2346.00	2.60	1.00	None	None	None	5.90	1017.60	19.00	2021270.59	122815.53
AK02-605	36Cl Swanson&Caffee2001	36Cl	36.58	29.58	2346.00	2.60	1.00	None	None	None	5.90	1017.60	19.00	2021270.59	122815.53
AK02-607	36Cl Demonstration Expt	36Cl	36.58	29.58	2341.00	2.60	2.50	None	None	None	5.90	1017.60	19.00	2770605.44	200078.25
AK02-607	36Cl Licciardi et al 2008	36Cl	36.58	29.58	2341.00	2.60	2.50	None	None	None	5.90	1017.60	19.00	2770605.44	200078.25
AK02-607	36Cl Phillips et al 1996	36Cl	36.58	29.58	2341.00	2.60	2.50	None	None	None	5.90	1017.60	19.00	2770605.44	200078.25
AK02-607	36Cl Swanson&Caffee2001	36Cl	36.58	29.58	2341.00	2.60	2.50	None	None	None	5.90	1017.60	19.00	2770605.44	200078.25
AK02-608	36Cl Demonstration Expt	36Cl	36.58	29.58	2334.00	2.60	2.00	None	None	None	5.90	1017.60	19.00	2225408.50	92170.35
AK02-608	36Cl Licciardi et al 2008	36Cl	36.58	29.58	2334.00	2.60	2.00	None	None	None	5.90	1017.60	19.00	2225408.50	92170.35
AK02-608	36Cl Phillips et al 1996	36Cl	36.58	29.58	2334.00	2.60	2.00	None	None	None	5.90	1017.60	19.00	2225408.50	92170.35
AK02-608	36Cl Swanson&Caffee2001	36Cl	36.58	29.58	2334.00	2.60	2.00	None	None	None	5.90	1017.60	19.00	2225408.50	92170.35
AK11-609	36Cl Demonstration Expt	36Cl	36.59	29.56	2165.00	2.60	2.00	None	None	None	5.90	1017.60	19.00	2162120.81	65722.04
AK11-609	36Cl Licciardi et al 2008	36Cl	36.59	29.56	2165.00	2.60	2.00	None	None	None	5.90	1017.60	19.00	2162120.81	65722.04

Figure 53. Age calculation software

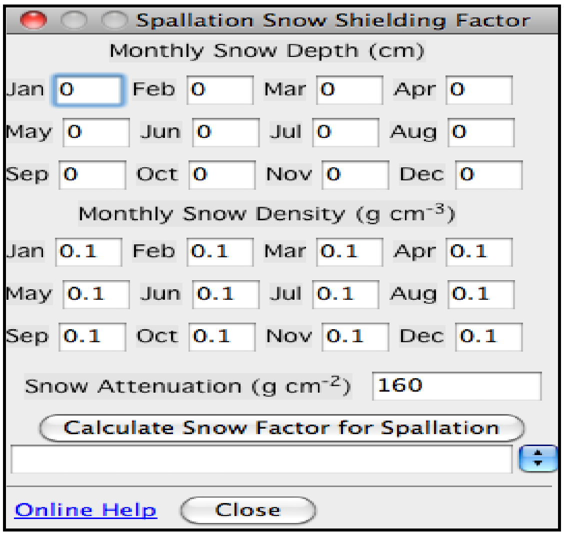


Figure 54. Spallation snow shielding factor

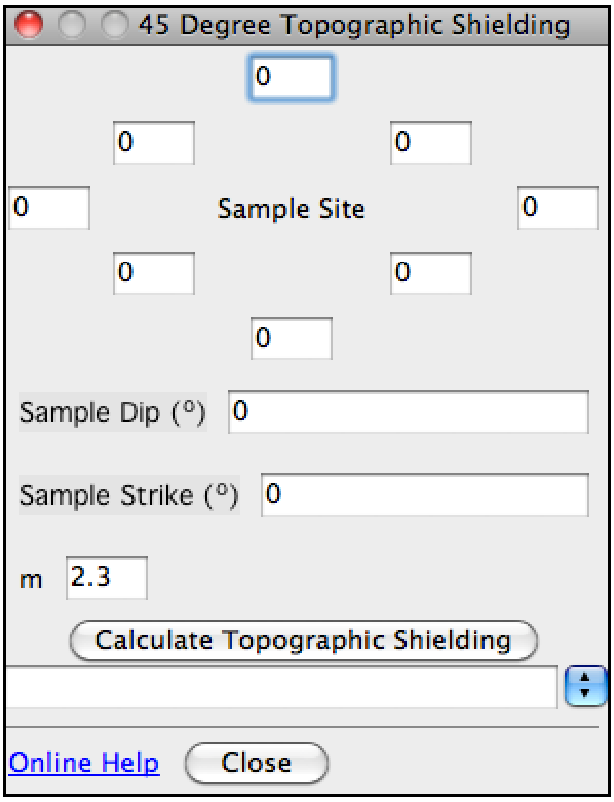


Figure 55. Topographic shielding calculation

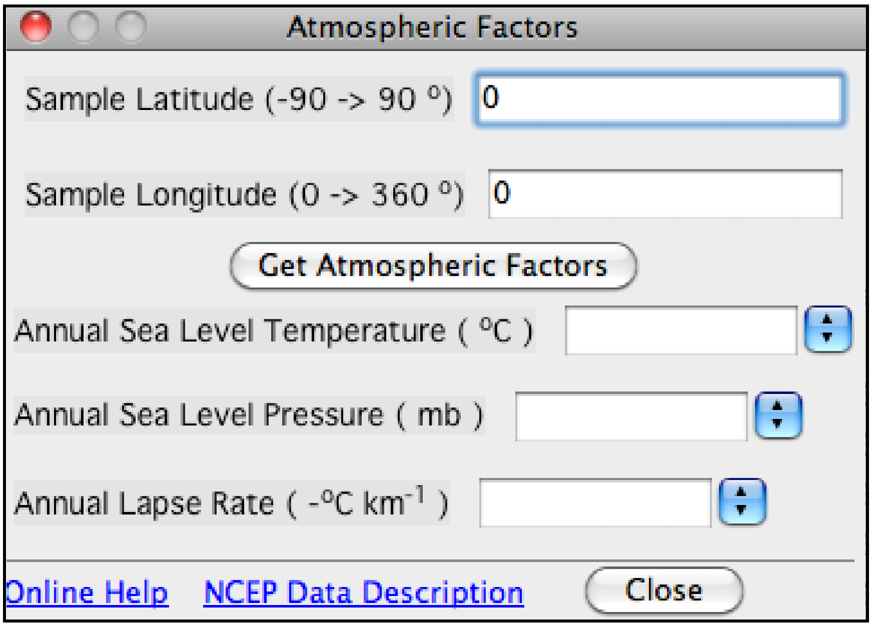


Figure 56. Calculation of atmospheric factors

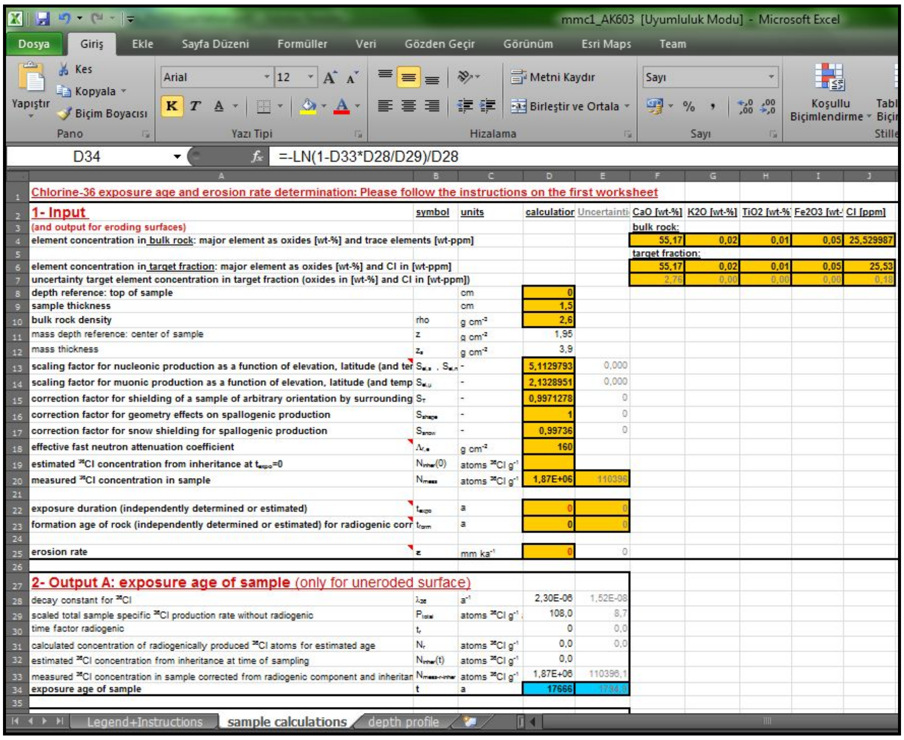
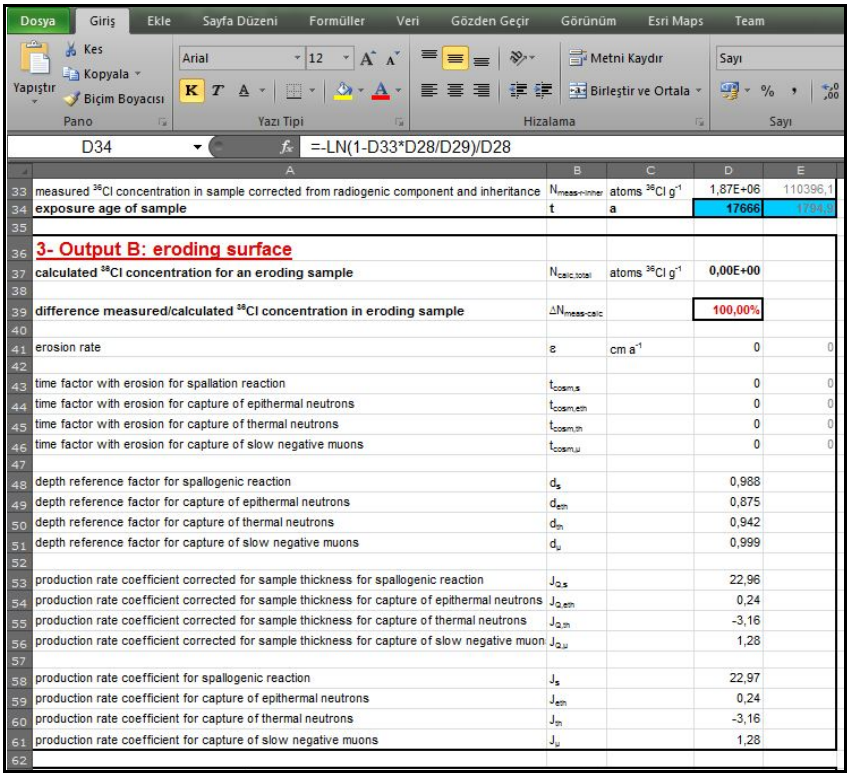


Figure 57. Chlorine-36 exposure age and erosion rate determination (input)



D34 =-LN(1-D33*D28/D29)/D28

	A	B	C	D	E
33	measured ^{36}Cl concentration in sample corrected from radiogenic component and inheritance	$N_{meas-r-inher}$	atoms ^{36}Cl g^{-1}	1,87E+06	110396,1
34	**exposure age of sample**	t	a	17666	1794,9
35					
36	**3- Output B: eroding surface**				
37	**calculated ^{36}Cl concentration for an eroding sample**	$N_{calc,total}$	atoms ^{36}Cl g^{-1}	0,00E+00	
38					
39	**difference measured/calculated ^{36}Cl concentration in eroding sample**	$\Delta N_{meas-calc}$		100,00%	
40					
41	erosion rate	ε	cm a^{-1}	0	0
42					
43	time factor with erosion for spallation reaction	$t_{cosm,s}$		0	0
44	time factor with erosion for capture of epithermal neutrons	$t_{cosm,eth}$		0	0
45	time factor with erosion for capture of thermal neutrons	$t_{cosm,th}$		0	0
46	time factor with erosion for capture of slow negative muons	$t_{cosm,\mu}$		0	0
47					
48	depth reference factor for spallogenic reaction	d_s		0,988	
49	depth reference factor for capture of epithermal neutrons	d_{eth}		0,875	
50	depth reference factor for capture of thermal neutrons	d_{th}		0,942	
51	depth reference factor for capture of slow negative muons	d_μ		0,999	
52					
53	production rate coefficient corrected for sample thickness for spallogenic reaction	$J_{Q,s}$		22,96	
54	production rate coefficient corrected for sample thickness for capture of epithermal neutrons	$J_{Q,eth}$		0,24	
55	production rate coefficient corrected for sample thickness for capture of thermal neutrons	$J_{Q,th}$		-3,16	
56	production rate coefficient corrected for sample thickness for capture of slow negative muon	$J_{Q,\mu}$		1,28	
57					
58	production rate coefficient for spallogenic reaction	J_s		22,97	
59	production rate coefficient for capture of epithermal neutrons	J_{eth}		0,24	
60	production rate coefficient for capture of thermal neutrons	J_{th}		-3,16	
61	production rate coefficient for capture of slow negative muons	J_μ		1,28	
62					

Figure 58. Chlorine-36 exposure age and erosion rate determination (output)

2.3. Studies related to human activities

Various definitions of transhumance have been made in the previous studies. When discussing the definition of highland (*yayla* in Turkish) in terms of physical geography, yayla is high platform that was carved by streams (İzbırak, 1992). In ancient times, yayla was used in the sense of a place of residence in summers opposed to winter residence (Sarı, 2013). The yayla term, in Orkhon inscriptions, was used to refer to high platforms or mountains where animals grazed (Ögel, 1978). One of the other definitions was based on nomadic animal husbandry and referred to yayla as mountain meadows where village herds stayed for a longer of time during the hottest periods of summer (Sarı, 2013). Another definition made about yayla was described as the mountain meadow where village herds went up and stayed during the hottest periods of summer (Alagöz, 1941). With another definition, yayla was referred to the place visited during certain period of summer for the purpose of animal grazing, agriculture, obtaining livelihood, and even relaxing (Tunçdilek, 1967). In addition to the definition of yayla, region of economic activity, which stands complementary to the village economy and is socially and economically connected to village, can be attached to the description of yayla (Doğanay, 1997). One of the definitions of yayla is as follows: yayla, when described as being place of settlement and economic activity area, can be defined as area in which different groups of socio-economic structure pay visit at certain period of the year and engage in humanistic and economic activities (Emiroğlu, 1977). In another study, the meaning of yayla was explained as such: yayla referred to a secondary section added to village's main subsistence area which was visited at certain period of summer for the purpose of grazing, engage in various tasks, relaxing, and which remains outside of village's course of life, often a common property of the village, separate from village, but connected to the village with socio-economic ties (Köse, 2001). In addition to this definition, yayla also includes activities that humans engage in such as going up to yayla accompanied by their animals, staying there for a while and involve in a number of economic activities during summer (Şişman, 2010). The yayla term, described in the law issued on February 28, 1998, was defined as "a place, in which farms spend summers together with their animals, was allocated for grazing their livestock and making use of their pasturage or used for this purpose since ancient times" (Sarı, 2013).

Looking at examples of yayla in the world, it was discovered by various studies that these activities were seen to be carried out in many places. Yayla is, in general, widely seen in South and Central Europe (Toroğlu and Kılınç, 2008), North Africa, Middle East, Central Asia (Kunze, 1987), West Africa and Southern USA (Huntsinger et al. 2010a). When examining the regions in the world where yayla is widely carried out in details, yayla is seen to be widespread in regions such as surroundings of Himalaya Mountains in India, Fagaras Mountains of Romania, North-west of Ethiopia, Tigray yayla of Ethiopia, North of Cameroon, Pirene Mountains located between Spain and France, Lot valley of France, South Oregon located at Western USA, Central and Southern part of Sudan, in Sweden, Mali, Senegal and Bhutan.

It is necessary to divide the purposes of yayla into two as its purposes in the past and those of the present. Although it was mostly used for grazing animals and agriculture in the past, but today, in spite of it being continued in some areas for this purpose, it mainly began to be used for the purpose of relaxing as well as tourism.

When place of yayla in Turkey was examined, yayla activities, considering Turkey's topographic structure and climatic conditions, can be seen in many regions in conjunction with animal husbandry (Doğu et al, 1999). Yayla is widely spread today due to reasons such as population increase in the regions of Turkey with hot summers, developments in agriculture and industry, and changes in income and living standards, and is particularly seen in places where urban population goes up (Sarı, 2013). Even though these are also called yayla, these settlements are places that possess the characteristics of summer-house (Sarı, 2013). In addition, although yayla in Turkey are generally situated on the mountains and yayla, these types of places are seen to be used like yayla (Toroğlu and Kılınç, 2008).

The purposes of yayla show development and change although husbandry activities are carried out today. The main reasons for these are population growth in general, increase in urban population, rise in economic level, and changes in agriculture and industry.

Considering the study area, four different transhumance settlements were examined in Akdağ. These yaylalar are Subaşı, Kuruova, İkizgöl and Taşkuzluklu. Socio-cultural and economic structure of these four yaylalar were examined in the study. In addition, the relationship between yayla activities and geomorphology was also investigated (Figure 59).

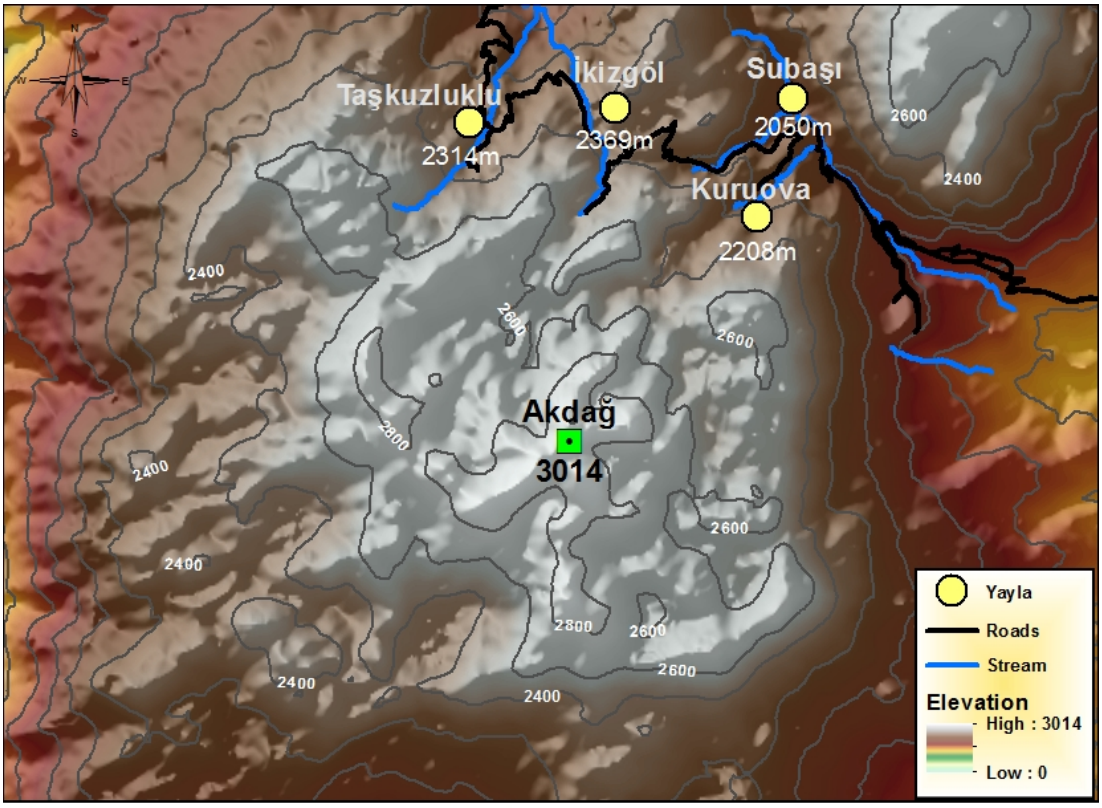


Figure 59. Location map of yayla

When looking at the relationship between yayla and geomorphology, we can say that they are seen to be connected (Doğu et al. 1993). It is due to the fact that when geomorphologic formations rise, the climate also changes in connection with altitude. Therefore, high lands are visited in these periods in order not to be affected by the temperature in summer months.

There is several house plans types on the yayla (Figure 60-61-62-63-64-65-66-67-68). Generally shelter tents established by one or two rooms. Tents established by different building materials. Materials are nylon, haircloth, wood, string, wire and stone.

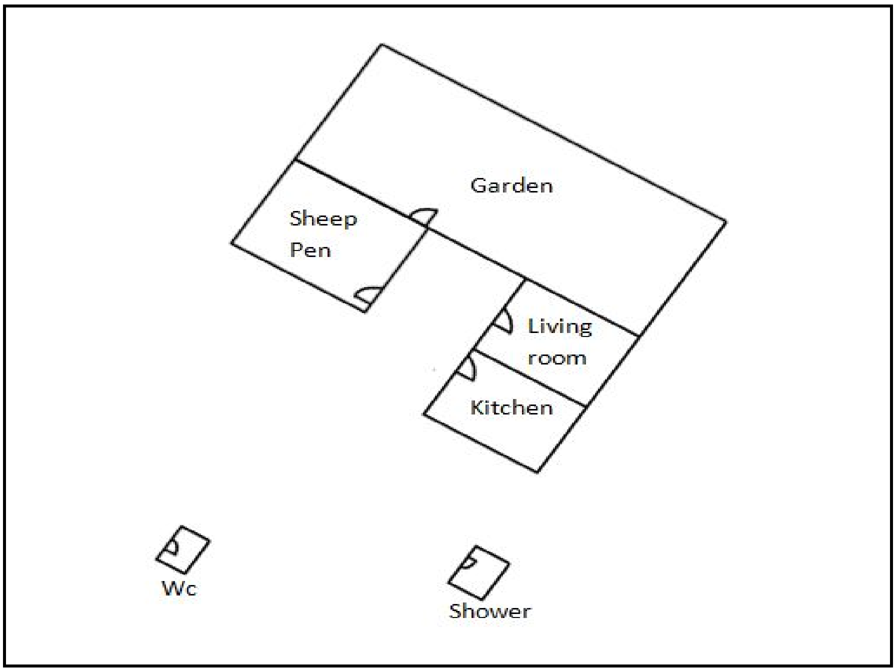


Figure 60. Plan of the tent (Subaşı yaylası)

Figure 61. An image related to plan of the tent (Subaşı yaylası)

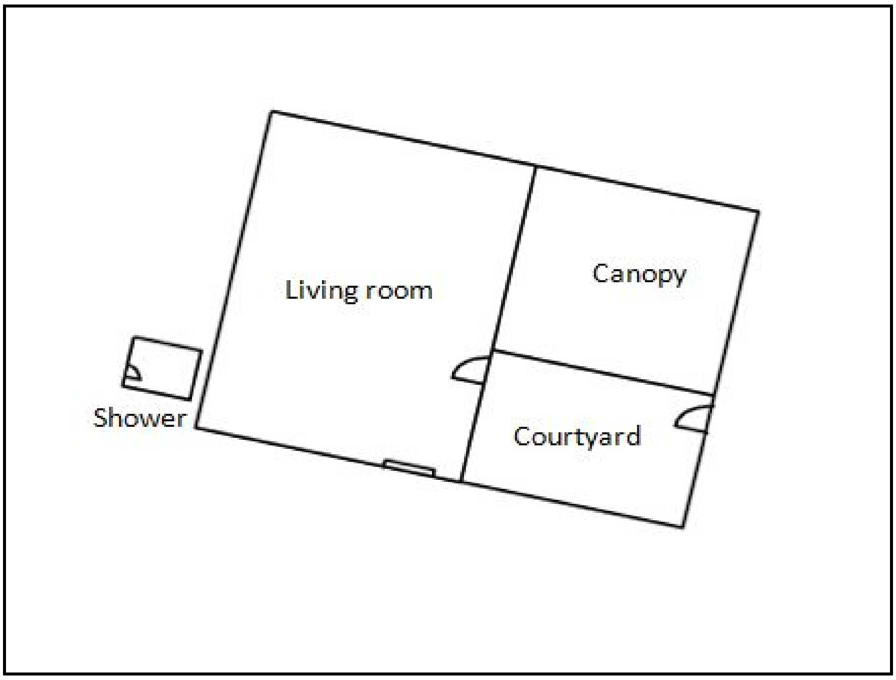


Figure 62. Plan of the tent (Kuruova yaylası)

Figure 63. An image related to plan of the tent (Kuruova yaylası)

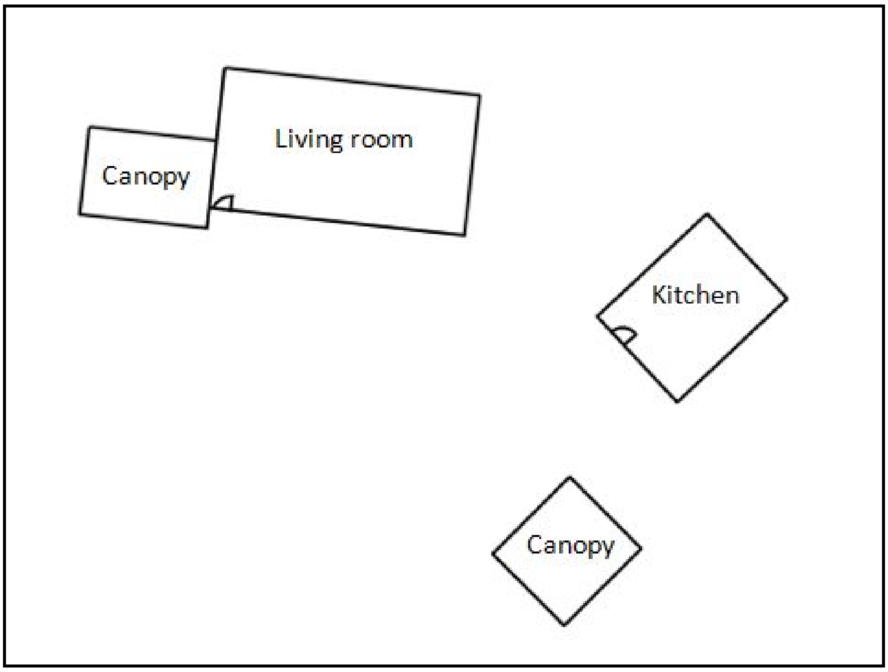


Figure 64. Plan of the tent (İkizgöl yaylası)

Figure 65. An image related to plan of the tent (İkizgöl yaylası)

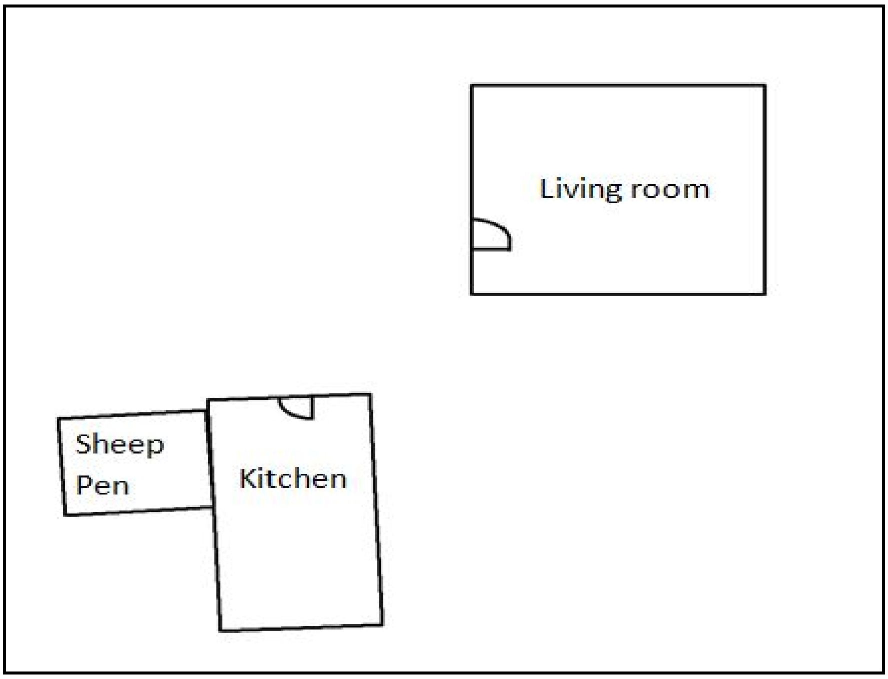


Figure 66. Plan of the tent (Taşkuzluklu yaylası)

Figure 67. An image related to plan of the tent (Taşkuzluklu yaylası)

Figure 68. Several photographs from inside of the tents

Chapter III: RESULTS

3.1. Results of the glaciers

Rock samples were taken from a total of 41 locations in Akdağ. Out of 41 rock samples, 11 of them were from the moraines located at Taşkuzluklu glacier valley, 10 of them from Karadere glacier valley, 15 rock samples from the moraines in Kuruova valley and 6 rock samples were taken from the moraines situated in the upper part of Kuruova. While calculating the ages of taken rock samples, their calculations were performed after making adjustments related to topographic, sample thickness, snow thickness and erosion. In addition, analytical errors were also indicated while conducting dating in rocks and moraines (Table 19).

Table 19. Ages of boulders and mean ages of glacial landforms on Akdağ

Sample ID	Surface	Boulder Age (ka)		Error (ka)	Used?	Landform Age
Taşkuzluklu Valley						
AK11-609	Terminal moraine	23.2	±	1.9		
AK11-610	Terminal moraine	20.6	±	1.7		
AK11-611	Terminal moraine	20.4	±	1.7		
AK11-613	Left lateral moraine	10.9	±	0.8	no	21.1±0.7
AK11-614	Left lateral moraine	22.3	±	1.8		
AK11-638	Right lateral moraine	20.9	±	1.7		
AK11-639	Right lateral moraine	22.0	±	1.7		
AK11-612	Left lateral moraine	16.6	±	1.3		
AK11-637	Right lateral moraine	16.3	±	1.3		
AK11-640	Terminal moraine	17.5	±	1.3		17.2±0.6
AK11-641	Terminal moraine	18.6	±	1.4		

Sample ID	Surface	Boulder Age (ka)		Error (ka)	Used?	Landform Age
Karadere Valley						
AK02-604	Right lateral moraine	22.1	±	2		
AK02-605	Right lateral moraine	19.2	±	1.6		
AK02-607	Terminal moraine	56.9	±	4	no	
AK02-608	Terminal moraine	21.2	±	1.8		20.4±0.8
AK11-642	Terminal moraine	21.2	±	1.6		
AK11-643	Terminal moraine	13.2	±	1	no	
AK11-644	Terminal moraine	20.7	±	1.6		
AK02-603	End moraine	18.4	±	1.9		
AK11-645	Right lateral moraine	11.5	±	0.9	no	17.6±1.1
AK11-646	Right lateral moraine	17.7	±	1.3		
Kuruova Valley						
AK11-616	Right lateral moraine	37.3	±	3		
AK11-622	Terminal moraine	49.4	±	4.1		
AK11-623	Terminal moraine	51.5	±	4.3		37.9±2.6
AK11-624	Terminal moraine	36.7	±	2.9		
AK11-626	Lateral moraine	33.4	±	2.6		
AK11-619	Right lateral moraine	21	±	1.6		
AK11-620	Terminal moraine	25	±	1.9		
AK11-621	Terminal moraine	24.8	±	1.9		
AK11-625	Terminal moraine	23.5	±	1.8		
AK11-627	Left lateral moraine	8.8	±	0.7	no	23.3±0.7
AK11-633	Terminal moraine	24.8	±	2		
AK11-635	Terminal moraine	24.1	±	1.9		
AK12-658	Left lateral moraine	11.4	±	0.9	no	
AK11-617	Right lateral moraine	18.7	±	1.5		17.2±1.0
AK11-618	Right lateral moraine	16.5	±	1.3		

Sample ID	Surface	Boulder Age (ka)	Error (ka)	Used?	Landform Age
Upper Kuruova Valley					
AK11-629	Complex moraine	39.8	± 3		31.8±2.9
AK11-630	Terminal moraine	25.3	± 1.9		
AK11-631	Terminal moraine	34.7	± 2.7		
AK11-632	Terminal moraine	29.8	± 2.3		
AK11-628	Lateral moraine	19.4	± 1.5		19.4±1.5

While creating sample age map and moraine age map of the research area, it was divided into three regions. These are, A) shows the dating results of samples and moraines in Taşkuzluklu ve Karadere glacier valleys, B) shows the dating results of samples and moraines in Kuruova glacier valley. In addition, C) the third region, shows the dating results of samples located at the top of Kuruova valley (Figure 69).

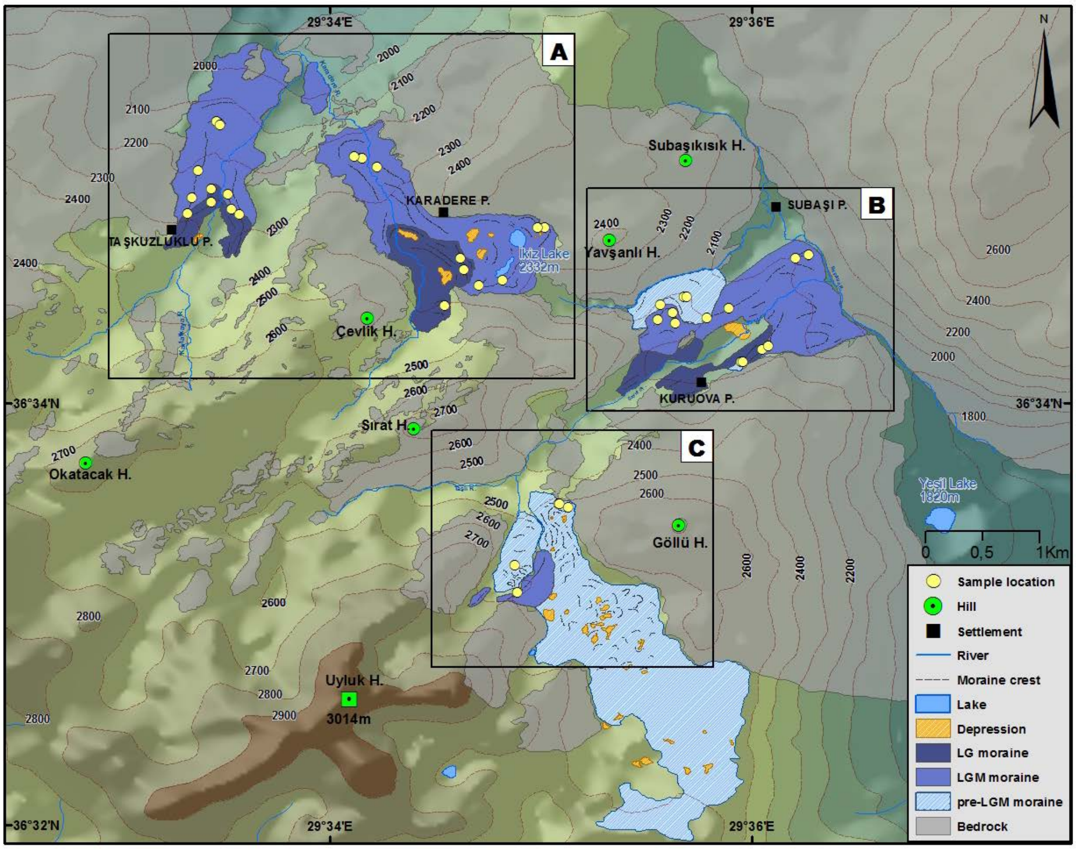


Figure 69. General map of the dated samples on Akdağ

3.1.1. Taşkuzluklu Valley and Karadere Valley

While a total of ten samples were taken from Taşkuzluklu, one of the samples was excluded from analysis due to the result of age. The ages of rocks in this valley are between 16.3±1.3 ka and 23.2±1.9 ka The weighted mean age of the moraines, where 609,610, and 611 numbered samples taken from the end of the glacial moraines, 64 numbered sample taken from the left-lateral moraine, 638 and 639 numbered samples taken from the right-lateral moraines, is 21.1±0.7 ka 613 numbered (10.9±0.8 ka) sample weight, found on the left-lateral of the moraines, was kept out of calculation, because it provided a younger age result different from other rocks and also gave a result of dating under standard deviation. The weighted age mean of the moraines, belonging to 612 numbered samples taken from the left-lateral moraine, 637 numbered sample taken from the right-lateral moraine and 640 and 641 numbered samples taken from the end of the moraines on the same valley, is 17.2±0.6 ka.

A total of ten samples were taken from Karadere valley. However, three of the taken samples were excluded from analysis even though their ages were determined. Samples that were excluded from analysis are 607, 643, and 645. While 607 numbered sample provided an older result in terms of average, 643 and 645 numbered samples gave younger results than the average. Since the age of 607 number sample is 56.9±4.0 ka, it is over the standard deviation; therefore, it was not included in the weighted age calculation. Ages of 643 and 645 numbered samples are calculated respectively as 13.2±1.0 and 11.5±0.9 ka, and remained below the standard deviation; therefore, they were not included in the weighted moraine age calculation. The ages of the samples taken from Karadere valley are in the range of 17.7±1.3 ka and 22.1±2.0 ka. The weighted mean age of the moraines, 604, and 610 numbered samples taken from the right-lateral of the moraines, and 608, 642 and 644 numbered samples taken from the end of moraines, is 20.4±0.8 ka. 607 and 643 numbered samples, found at the end of the moraine, were excluded from the weighted age calculation of the moraine. The weighted mean age of the moraines, 603 number sample taken from the last moraine, and 646 numbered sample taken from the right-lateral of moraines, is calculated as 17.6±1.1 ka (Figure 70).

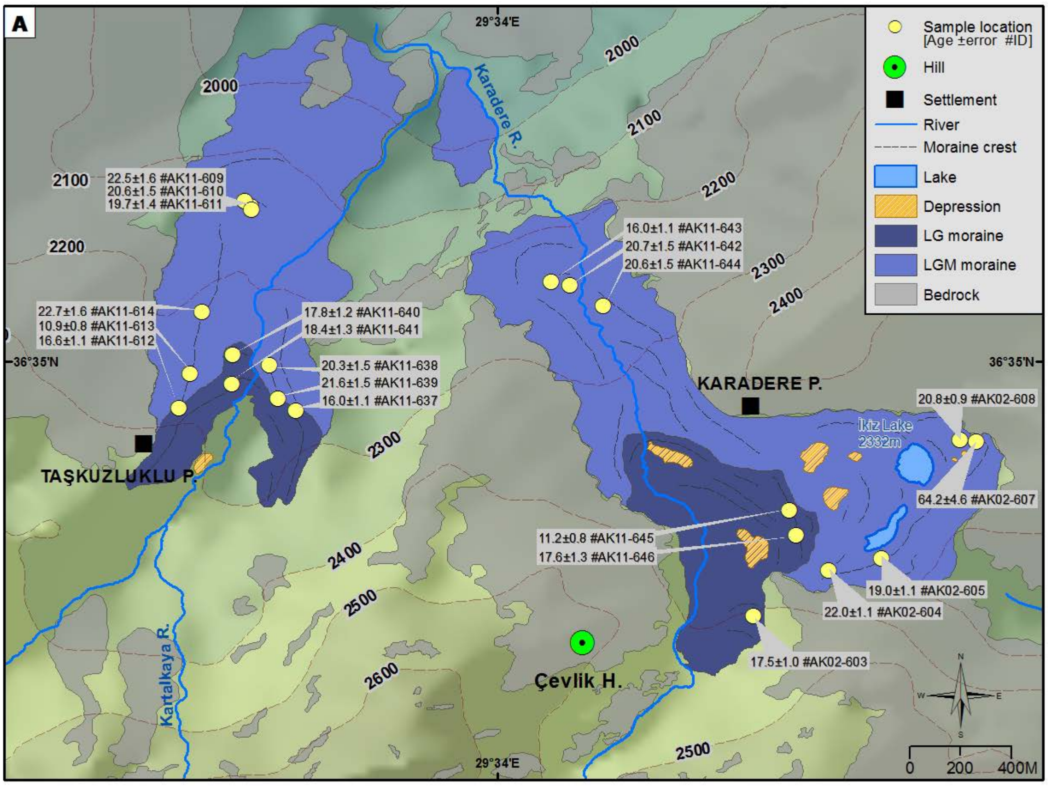


Figure 70. Ages calculated samples map of the Taşkuzluklu and Karadere valleys

3.1.2. Kuruova Valley

A total of fifteen samples were taken from Kuruova valley and ages of the two samples out of fifteen were excluded from analysis. The samples, which were excluded from analysis, are 627 and 658. The ages of 627 and 658 numbered samples are 8.8±0.7 ka and 11.4±0.9 ka respectively. Two samples, whose ages had been calculated, remained below the average and therefore, they were not included in the weighted age calculation of the moraines. The ages of the samples taken from Kuruova are in the range of 16.5±1.3 ka and 49.4±4.1 ka The weighted ages of 616 numbered samples taken from the right-lateral of the moraine, 622, 623, and 624 numbered samples taken from the left-lateral of the moraines and 626 numbered sample taken from the lateral of the moraine, were calculated as 37.9±2.6 ka. The weighted age mean of 619 numbered samples taken from the right-lateral of the moraine, 658 numbered samples taken from the left-lateral of the moraines and 620, 621, 625, 633 and 635 numbered sample taken from the end of the moraine, were calculated as 23.3±0.7 ka. The weighted age mean of 617 and 618 numbered samples taken from the right-lateral of the moraine, was calculated as 17.2±1.0 ka (Figure 71).

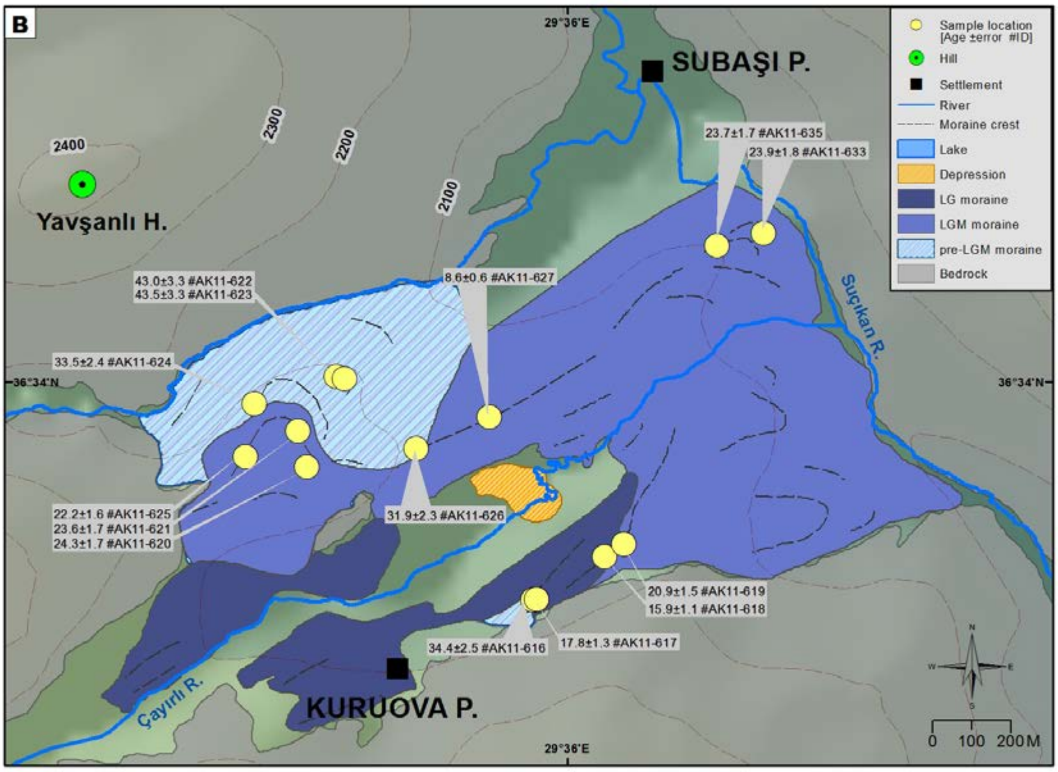


Figure 71. Ages calculated samples map of the Kuruova valley

3.1.3. Upper Kuruova Valley

A total of six samples were taken from the moraine located on Kuruova valley. The result of the weighted age mean of 629 numbered samples taken from the complex moraine, and 630, 631 and 632 numbered samples taken from the end of the moraine was calculated as 31.8±2.9 ka. The ages of the samples in this moraine are in the range of 19.4± and 39.8±3.0 ka (Figure 72).

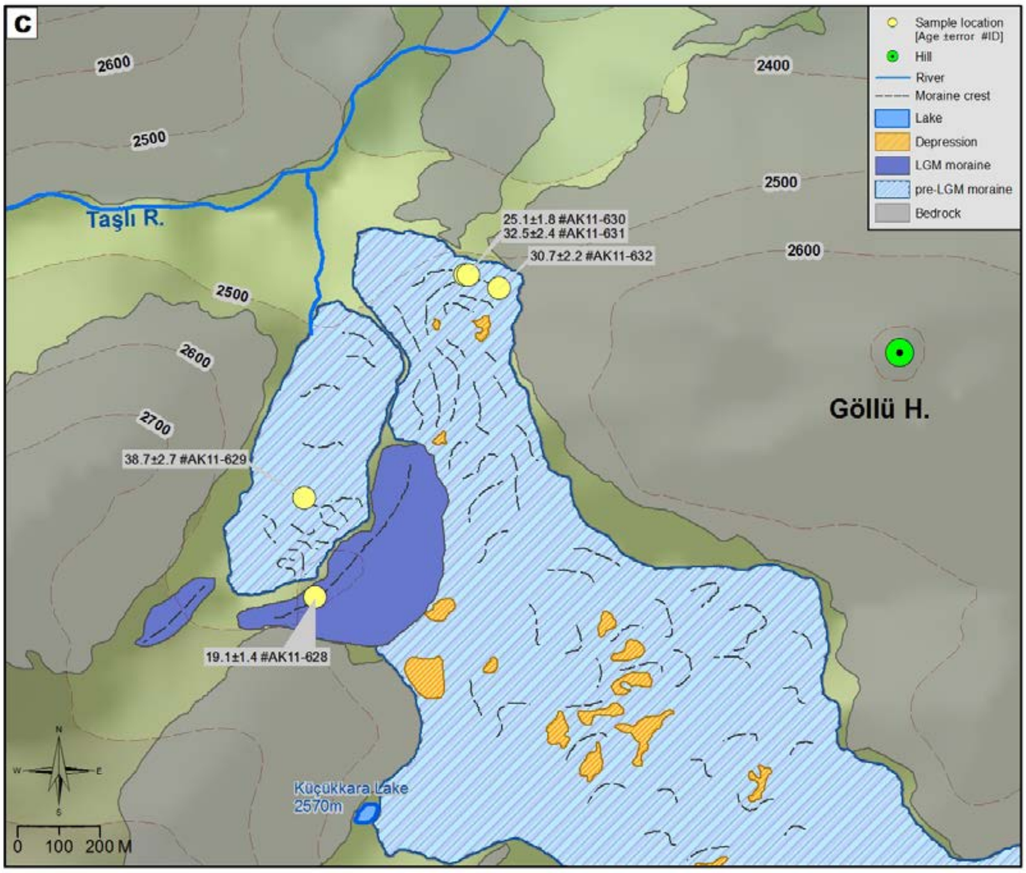


Figure 72. Ages calculated samples map of the Upper Kuruova valley

3.2. Human geography results

Yayla activities are carried out in Akdağ region for many years. While yayla, engage in human activities by migrating to higher areas in summer, they live in villages located in the coastal and low-lying areas in winter.

In the study conducted on human activities in Akdağ region, information on socio-cultural and economic structure of the region was obtained. In addition apart from examining the socio-cultural and economic structure of the region, what type of relationship yayla in the region had with geomorphology in their surroundings was also examined.

As a result of the study, yayla areas in the north and northeast of Akdağ were examined. These yaylalar areas are Subaşı, Kuruova, İkizgöl and Taşkuzluklu. When examining the relations of yayla areas located at Akdağ with geomorphology, these areas were seen to have a tight connection with geomorphologic formations. The yayla settlements were established at the lower parts of the sediment, plain and areas with suddenly-risen geomorphology. The reason for this is to be protected from the cold. The elevations of the yaylalar were determined by the help of GPS (refer to table). The elevation and location of the yayla areas make it possible to carry out yayla activities for the period of 2-3 months. This finding was supported with surveys conducted in the research area (Table 20).

Table 20. Name and Elevations map of the yayla

Yayla Name	Province	District	Geographic Location	Elevation (m)
Subaşı	Antalya	Kaş	Flat Area	2050
Kuruova	Antalya	Kaş	Flat Area	2140
İkizgöl	Muğla	Fethiye	Flat Area	2330
Taşkuzluklu	Antalya	Fethiye	Hillside	2250

In addition to the relationship with human activities and physical factors, it was observed that places of settlements were established at areas located at the vicinity of water resources and depressed areas in the south of the risen mountain slope in order to be protected from the cold (Figure 73).

Figure 73. An image from Subaşı Yayla

When looking at the number of households and population of yayla in the research area, while there are 6 households in Subaşı yayla, its population is 18. While the number of households is 5 in Kurukova, its population is 14. The number of households located at İkizgöl locality is 14 and its population is 58. While the number of households is 6 in Taşkuzluklu yayla, its population is 24. One of the reasons for the crowdedness of the settlement in İkizgöl yayla originates from the abundance of water resources in this region. Another reason for its crowdedness is the display of distribution in one region due to yayla, found in this region, mainly being from the same village. According to data, obtained in 1996, it was indicated that there were 31 households and 125 people lived in this yayla (Doğu et al. 1999). As of 2012, a total of 31 households are present and 114 people live in these four yayla areas (Table 21).

Table 21. Population of the yayla

Yayla Name	Number of Settlement	Total Population	Male	Woman	Child
Subaşı	6	18	6	5	7
Kuruova	5	14	6	5	3
İkizgöl	14	58	20	19	19
Taşkuzluklu	6	24	6	6	12

When looking the objectives of transhumant (*yaylacı* in Turkish) for going up to the yayla, the result of 58% of yayla coming up to the yayla for the reason of husbandry was emerged. 36% of yayla indicated that they came up to the yayla for the objective of relaxing. It was responded in the survey questions that the remaining 6% of transhumant came up to the yayla for the objective of engaging in beekeeping activities (Figure 74).

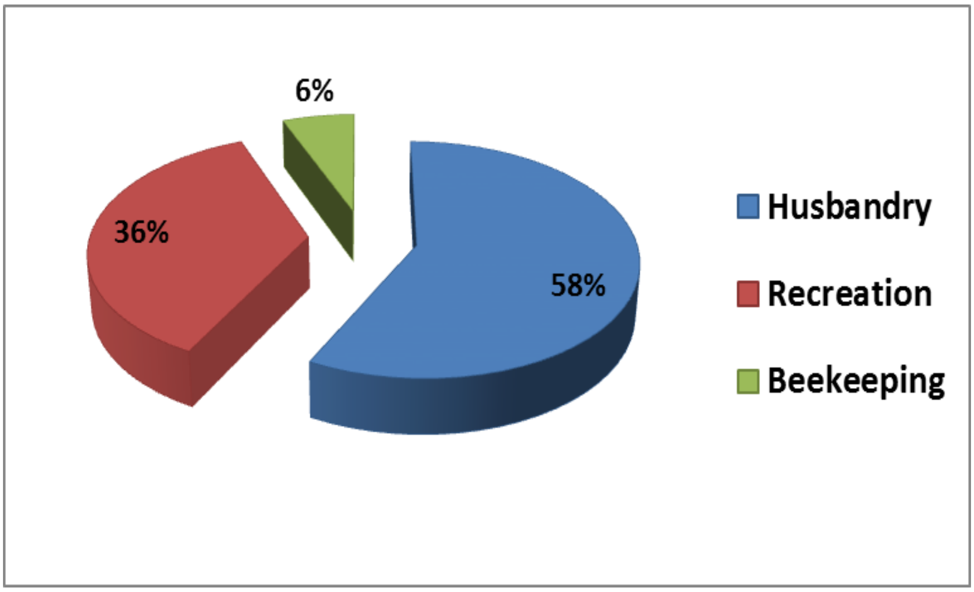


Figure 74. Purpose of the transhumant to go yayla

When people, living in yayla, were asked a question whether they were pleased to live there, 81% of transhumant indicated that they were pleased. Transhumant stated their displeasure in the rate of 16%. The remaining 3% also remained indecisive (Figure 75).

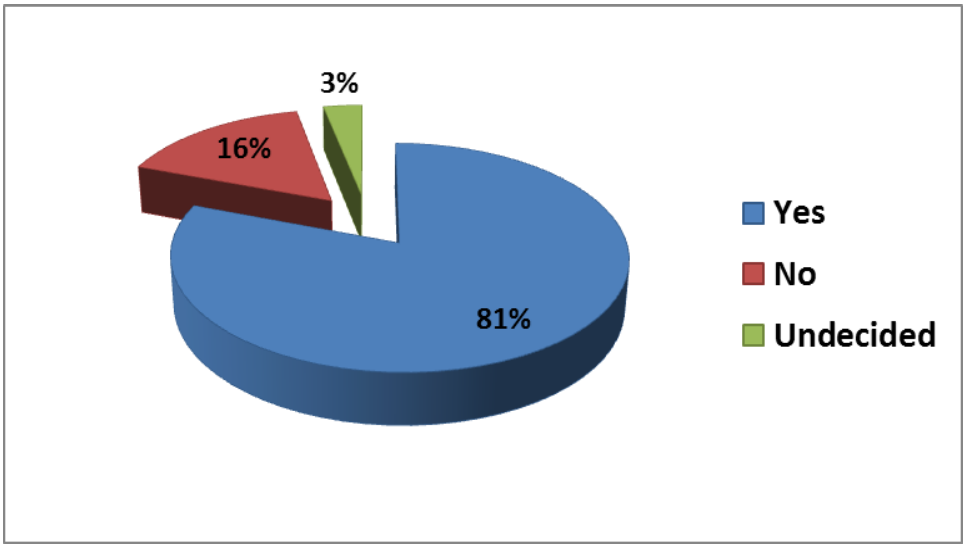


Figure 75. A question of the transhumant's life pleasure

In a question directed at transhumant about the time of their going up to the yayla, 69% of transhumant indicated that they go up to the yayla in the month of June. Other transhumant, with the rate of 22%, stated that they go up to the yayla in May and 9% of transhumant stated that they go up within the month of July. When looking at transhumant date of return to their villages, 48% of transhumant return in the month of September. 39% of transhumant return to their villages in August. While the remaining 10% of transhumant stated that they return to their villages in October, 3% of them stated that they return in July. When looking at the number of days transhumant spend in the yayla, it was dertemined that 40% of them stay in yayla between 31-35 days. 30% of transhumant indicated that they stay in yayla between 46-60 days. The remaining 30% of them stated that they lodge in yayla between 21-30 days (Figure 76).

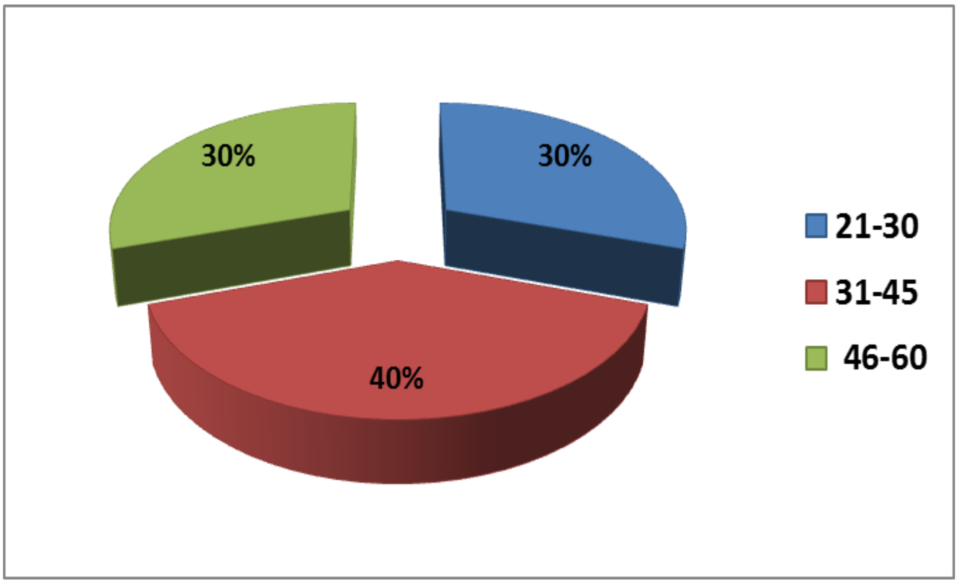


Figure 76. Residence time of transhumants in the yayla

When looking at the duration of transhumant's going up to the yayla, 42% of transhumant stated that they go up to yayla within one day from their villages. 26% of transhumant stated that they go up to yayla within two days from their villages. Similar rate of transhumant indicated that they go up to yayla from their villages within 3 days. The remaining 6% of transhumant responded that they go up to yayla from their villages within 4 days (Figure 77).

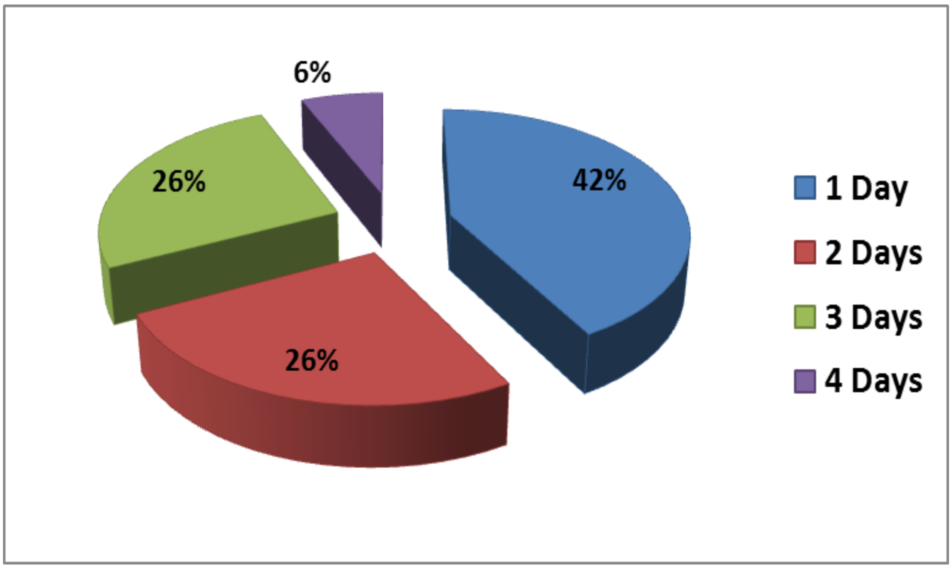


Figure 77. Getting time of the transhumants to yayla

When looking at the distance between transhumant's barracks villages and the yayla areas, 87% of transhumant is stated that it was 70 km and above. The remaining 13% of transhumant was stated to be between 50-70 km (Figure 78).

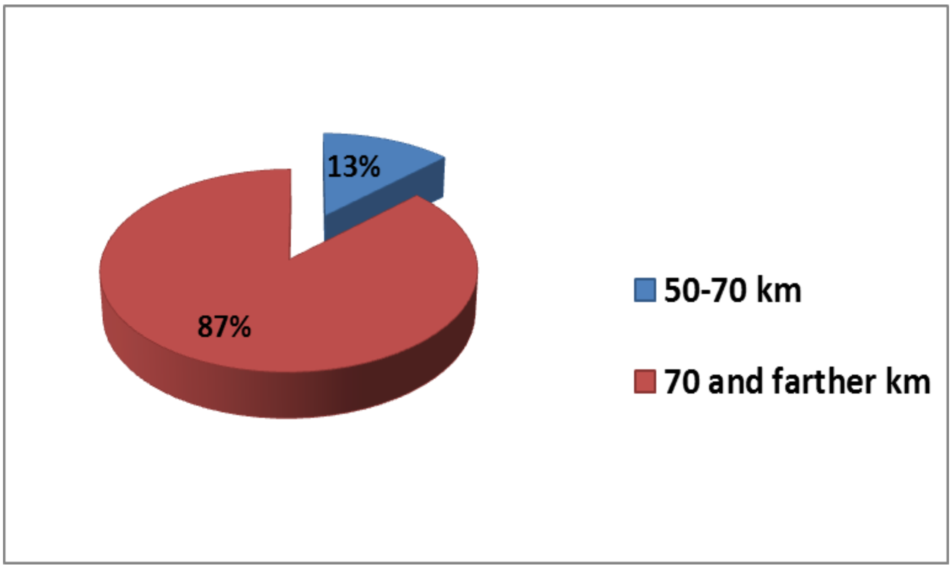


Figure 78. Distance between town and yayla of the transhumants

Accommodation in the yayla is made inside bristle or nylon tents and prefabricated homes. 61% of transhumant-people render lodging in nylon tents. 23% of transhumant people live in bristle tents. The remaining 16% of transhumant-people stay in prefabricated homes (Figure 79).

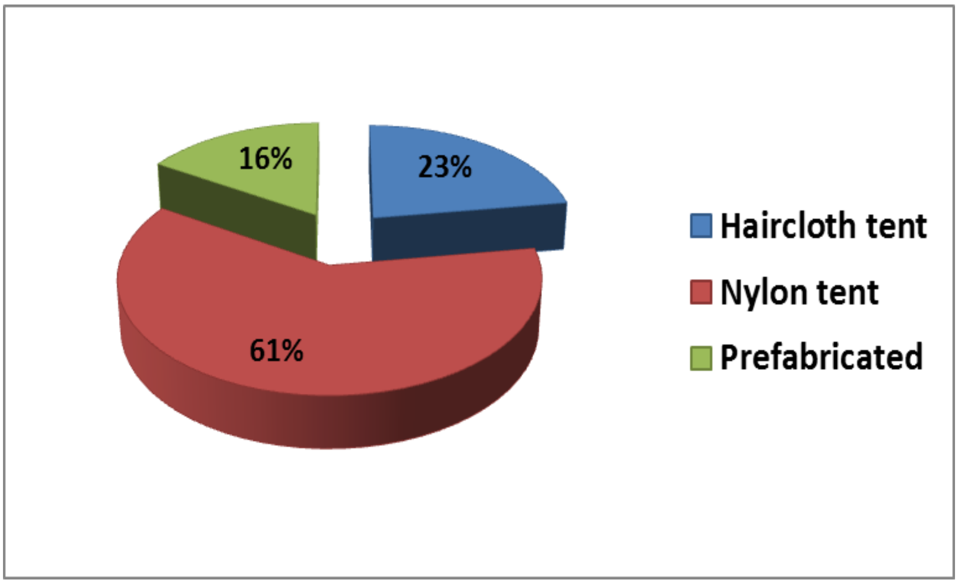


Figure 79. Question about where transhumants live

When looking at the economical activities of the transhumant-people, the rate of transhumant, whose go up to the yayla since their only means of livelihood is husbandry, is 80%. However, the rate of transhumant-people, whose only means of livelihood is not husbandry, is 20%. Apart of husbandry, the rate of transhumant-people, who engage in agriculture to provide for their livelihood, is 20%. 80% of them engage in agriculture. Thus, those, who take up transhumance for the purpose of husbandry, go up to the yayla only for the purpose of husbandry.

Transhumant-people, who go up to yayla for the purpose of husbandry, stated by 90% that they bring ovine to yayla in order to raise them. The remaining 10% of them take their animals to the yayla for raising bovine there (Figure 80).

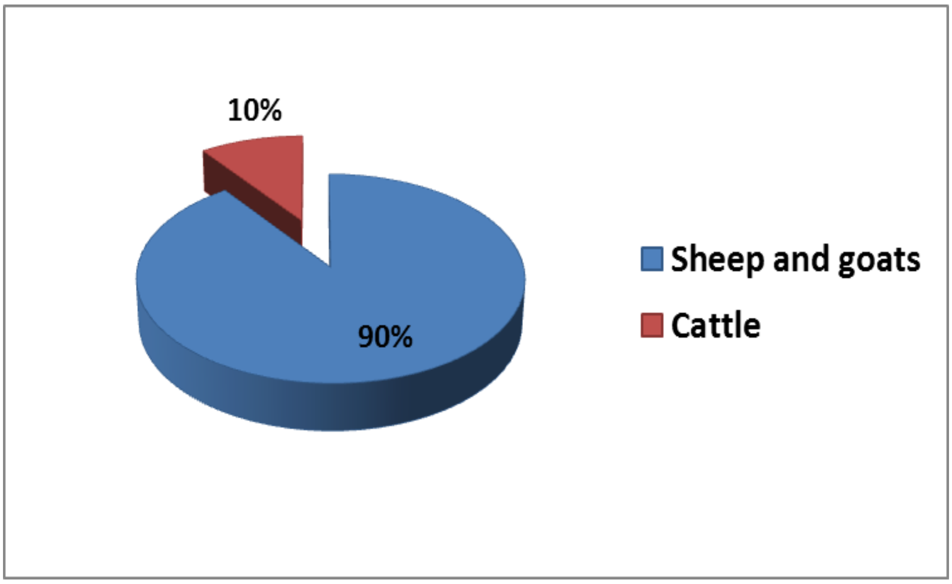


Figure 80. A question about what kind of animals transhumants carry away to yayla

When looking at the number of animals in the yayla, sheep stock-breeding mostly is carried out in the yayla. Next stock-breeding, after sheep, is consisted of goats. Animal species, after goats, is kids. Finally, cattle breeding takes place in the yayla (Figure 81-82).

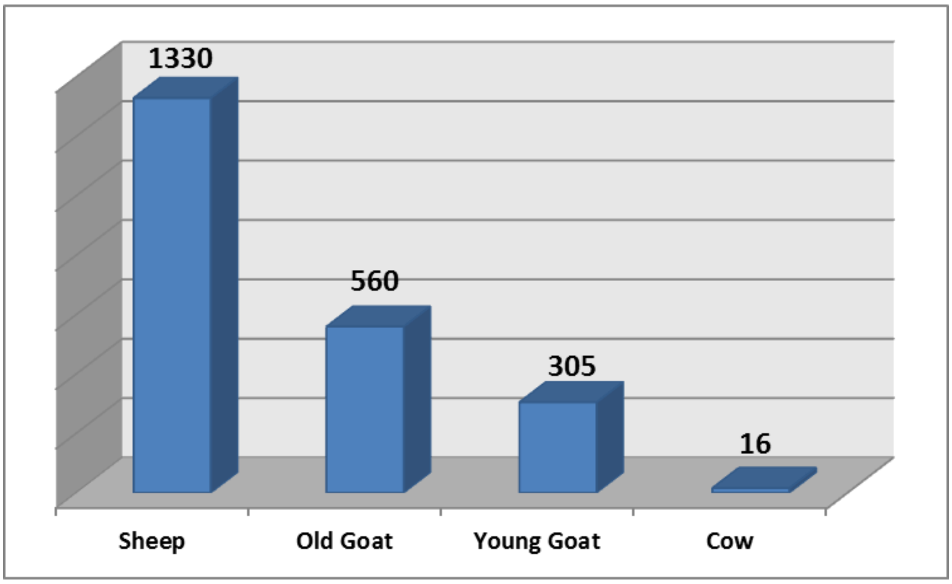


Figure 81. Animal population in the yayla

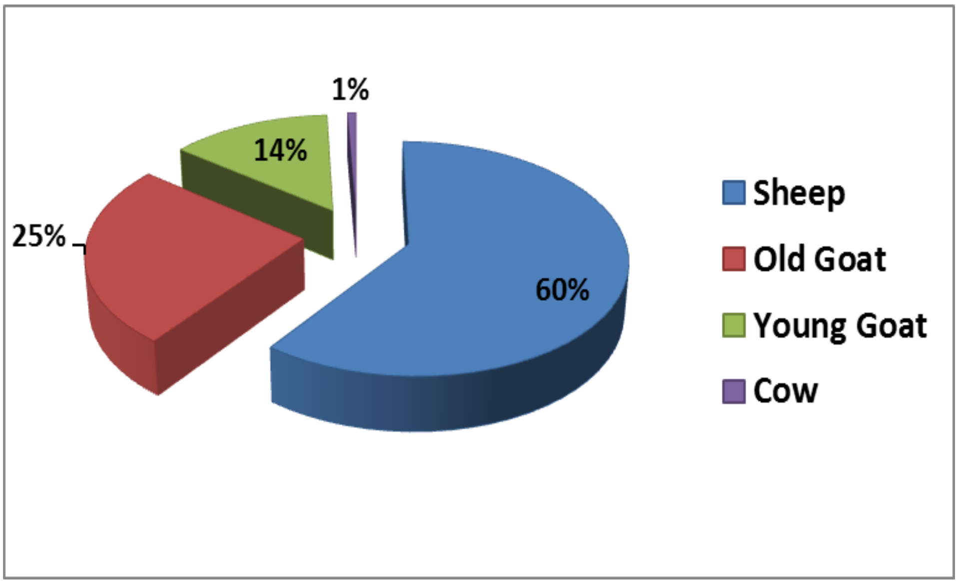


Figure 82. Animal population rate by species in the yayla

92% of milk milked in the yayla is used to make cheese. Yoghurt is produced by 8%. 67% of milk produced in yayla is sold to either relatives or acquaintances. The remaining 33% of milk is sold in villages or markets (Figure 83).

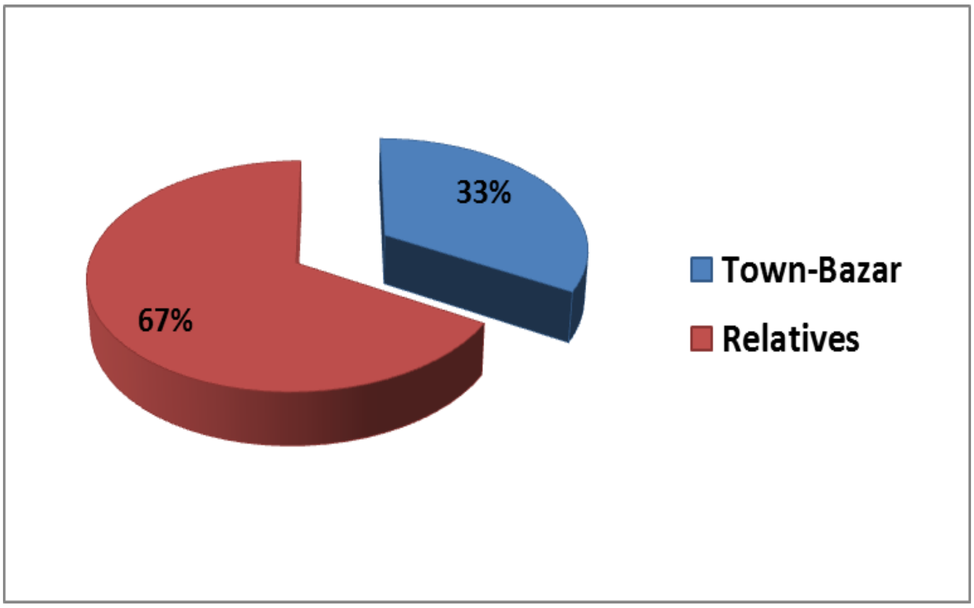


Figure 83. Outlets of the milked milk

3.2.1. Economic activities

Altitude is one of the most important factors affecting the economic activities of transhumant in the study area (Güner and Ertürk, 2005). While carrying out agriculture and husbandry in the areas less than 2000 meters, only husbandry takes place in yayla areas over 2000 meters. (Figure 84).

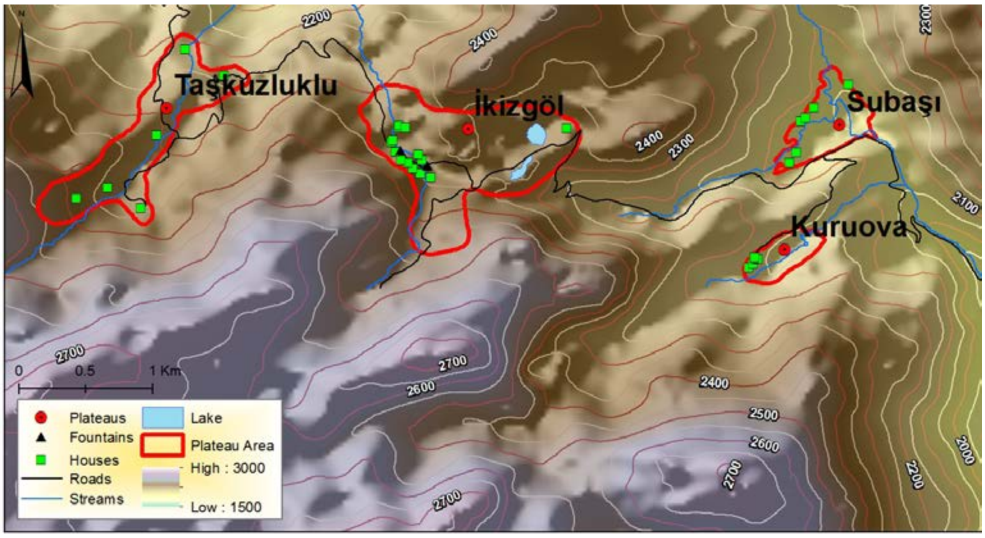


Figure 84. Yaylalar of Akdağ

People, who live in 31 households and engage in yayla activities in Subaşı, Kuruova, İkizgöl and Taşkuzluklu, go up to the yayla for the purpose of husbandry with the rate of 58%, relaxing with the rate of 36% and beekeeping with the rate of 2%. Those, who go up to yayla for the purpose of relaxing, are learnt to be engaged in green-housing in the year. People, who engage in green-housing activities, mostly grow vegetables in their villages or towns. Husbandry activities, in these four yayla, are largely noted to show distribution of ovine breeding. This rate is 90% in ovine breeding and 10% in bovine breeding. The distribution of animals is sheep with the rate of 46%, goat with the rate of 27%, kid with the rate of 23 %, and cow with the rate of 4%. In addition, transhumant, when directed a question "Is transhumance is your only source of livelihood" with the purpose of husbandry, responded as "yes" with the rate of 80% and "no" with the rate of 20%. Another question directed at transhumant was "is agriculture being done in yayla as a source of livelihood apart from husbandry." While 80% of transhumant responded as "no," 20% responded as "yes."

From milk obtained from animals, while cheese is produced in the rate of 92%, yoghurt is produced in the rate of 8%. Produced milk products were sold in family circle with the rate of 60%, in the village – market with the rate of 30 and in the markets with the rate of 30%.

Another activity executed in terms economy is the snow trade. Few people, engaged in transhumance, perform the act of selling the snow that they obtained from the summit of Akdağ or its surroundings after carrying it down to the town of Gömbe. This snow is used in the making of syrup by the people. Agricultural products of transhumant in the study area are also available. But this act of production is not seen in all the yayla. Produced agricultural products are vegetable-type products. In addition, nine households, out of thirty-one, meet with their own daily electricity needs by using solar energy.

3.2.2. Social and touristic activities

When examining the social life of four yayla in Akdağ, the knowledge of more social activities being carried out 20-30 years ago was reach as a result of the interviews conducted in the yayla region. It was indicated that activities, such as camel wrestling, summer festivals and weddings, were conducted in the past. However, information on no such activities being conducted today was obtained as result of the surveys and interviews. In the past, it was stated that transhumant, unless they were forced to, did not cut off their connections with their villages (Doğu et al. 1999). However, transhumant indicated that they go down to the village or to the town of Gömbe located in the foothills of Akdağ from the yayla areas due to the developments in the means of transportations today.

There are 31 households in the four yayla areas. Total number of people living in these households is 186. 18 people live in Subaşı yayla. The number of people living in Taşkuzluklu yayla is 24. The number of transhumant living in İkizgöl region is 58. The number of people living in the yayla of Kuruova is 14. Of these 64 are men, 59 are women and 63 are children. While 14 people live in the yayla of Kuruova, of these 6 are men, 5 are women and 3 are children. The rate of population distribution in the yayla is given below: The number of people living in Subaşı yayla is 18. Of these 6 are men, 5 are women, and 7 are children. The population distribution graph of this region is given below. The number of transhumant living in İkizgöl region is 58. Of these 20 are men, 19 are women and 19 are children. The population distribution graph of this area is as follows. The number of people living in Taşkuzluklu area is 24. Total number consists of 6 men, 6 women and the other 12 children. In the map shown below, road routes of transhumant that follow during migration from Kaş district to the yayla are displayed below. Transhumant reach at their places of settlement in the yayla with their animal herds by covering the way shown in the map almost in 2-3 days. When moving to yayla, it was stated by transhumant that yayla equipments sometimes were transported by a vehicle, and sometimes animals were also carried in vehicles (Figure 85).

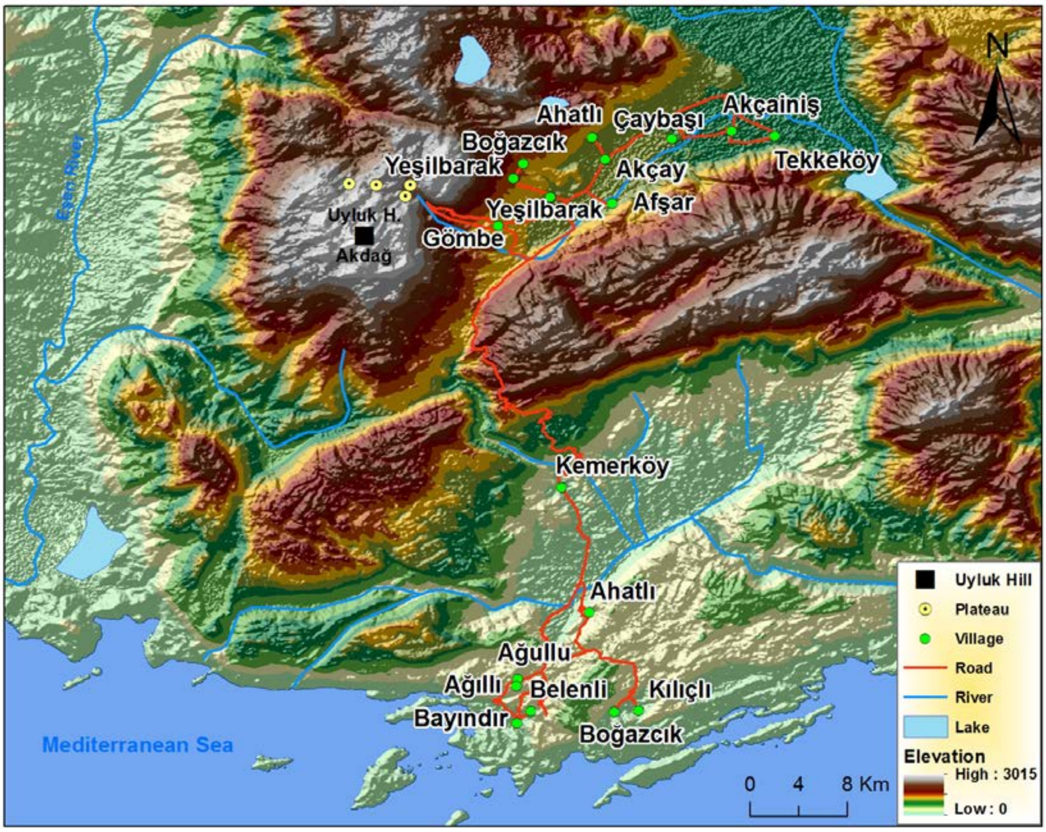


Figure 85. Yayla routes

CHAPTER IV: CONCLUSION

4.1. Conclusion of the paleoglacier's of Akdağ

We provided contribution, with the study we conducted, to the studies conducted by Cosmogenic ^{36}Cl dating method for the glacier deposits in Turkey. While dating rocks, samples were taken from their glacial valley. These valleys are Taşkuzluklu, Karadere and Kuruova. While performing dating on 41 rock samples, 6 of them were not included in the weighted mean of the moraines during the study. The ages of the samples taken from Akdağ cover the periods of pre-LGM (previous Last Glacial Maximum), LGM (Last Glacial Maximum) and LG (Late Glacial). The nine each rocks, belonging to Pre-LGM and LG periods and twenty-three rocks, belonging to LGM period were dated.

Cosmogenic aging of eleven samples, taken from the moraines in Taşkuzluklu glacial valley, was carried out. Only one sample, out of eleven, was not included in the weighted mean. When the weighted mean age of the moraines was calculated, results, belonging to two different glacial periods, were discovered. These results belong to LGM and LD periods. The end time of the largest expansion of the glacier in Taşkuzluklu valley occurred 21.1±0.7 thousand years ago. The weighted mean dating of this moraine shows that it belonged to LGM period. As a result of the calculation of the second moraine's weighted mean, it turned out to be from 17.2±0.6 thousand years ago. This calculation indicates that glaciers are moving again (Figure 86-87).

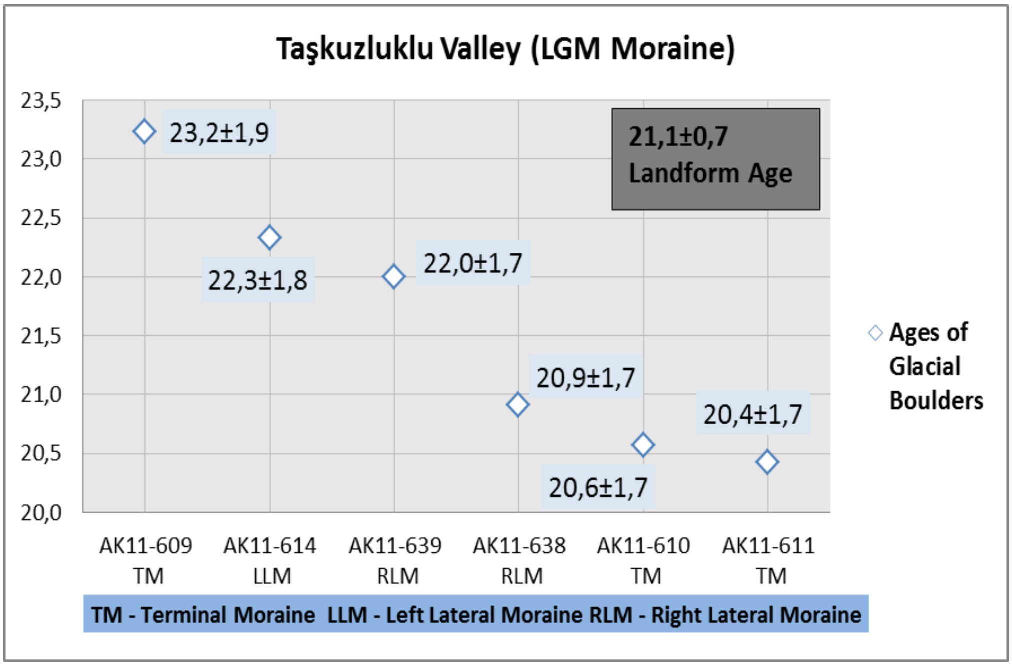


Figure 86. Ages of boulders and age of moraine on Taşkuzluklu Valley (LGM Moraine)

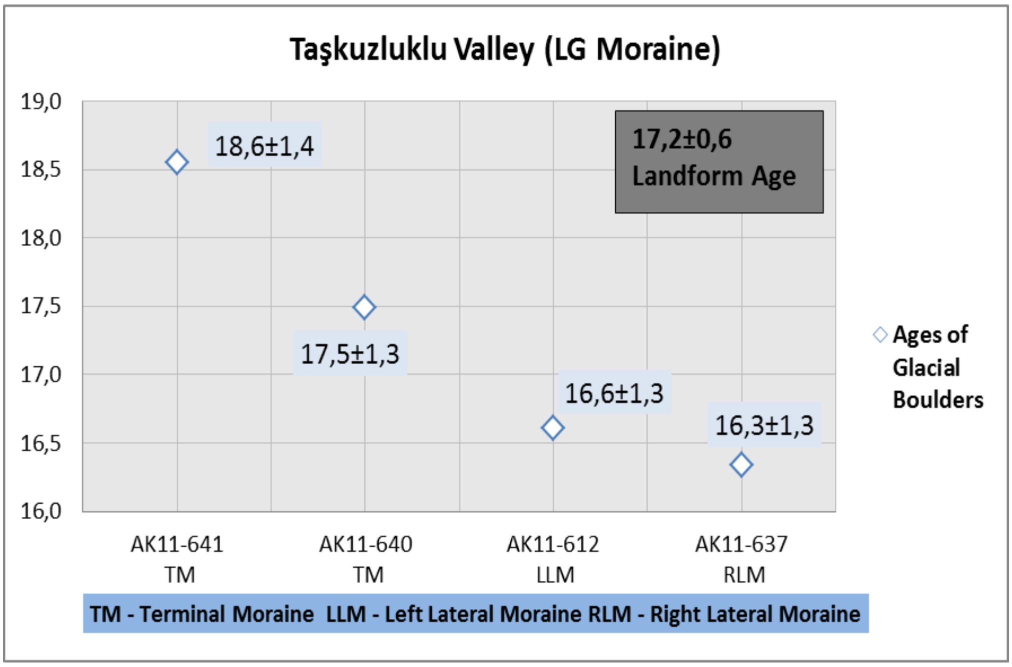


Figure 87. Ages of boulders and age of moraine on Taşkuzluklu Valley (LG Moraine)

Cosmogenic aging of ten samples, taken from the moraines in Karadere glacial valley, was carried out. Three samples, out of eleven, were not included in the weighted mean. The ages of the samples, taken from Karadere glacial valley, cover two different glacier period. These periods are LGM and LG. The largest expansion of the glacier in Karadere occurred 20.4±0.8 thousand years ago. The result of this age calculation indicates that it took place at LGM period. As a result of the calculation of the other weight mean, the further movement of glaciers was calculated to happen 17.6±1.1 thousand years ago. This calculation proves that it occurred in LG period (Figure 88-89).

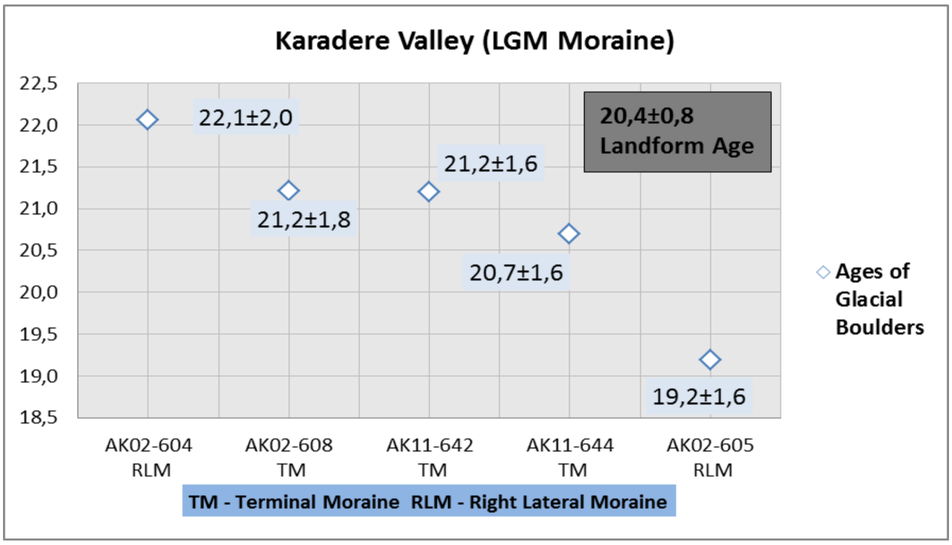


Figure 88. Ages of boulders and age of moraine on Karadere Valley (LGM Moraine)

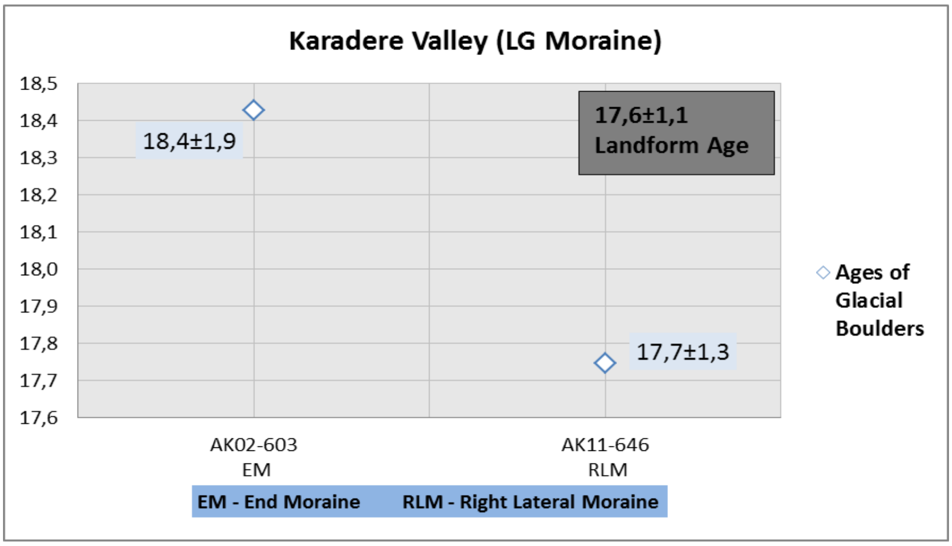


Figure 89. Ages of boulders and age of moraine on Karadere Valley (LG Moraine)

Cosmogenic aging of fifteen samples, taken from the moraines in Kuruova glacial valley, was carried out. Two samples, out of fifteen, were not used in the calculation of the weighted mean age. When taken the weighted mean age of the moraines, results of cosmogenic age calculation, belonging to three different glacial periods, showed up. These are pre-LGM, LGM and LG glacial periods. The mean age of the moraine, belonging to Pre-LGM period, indicates that glaciers moved 37.9±2.6 thousand years ago. Another age calculation of the moraine proves that glaciers moved again 23.3±0.7 thousand years ago. The result of this moraine's dating demonstrates that it happened in LGM period. The result of the third moraine's dating shows also that glaciers moved again 17.2±1.0 thousand years ago. The result of the moraine's dating shows that movement occurred in LG period (Figure 90-91-92).

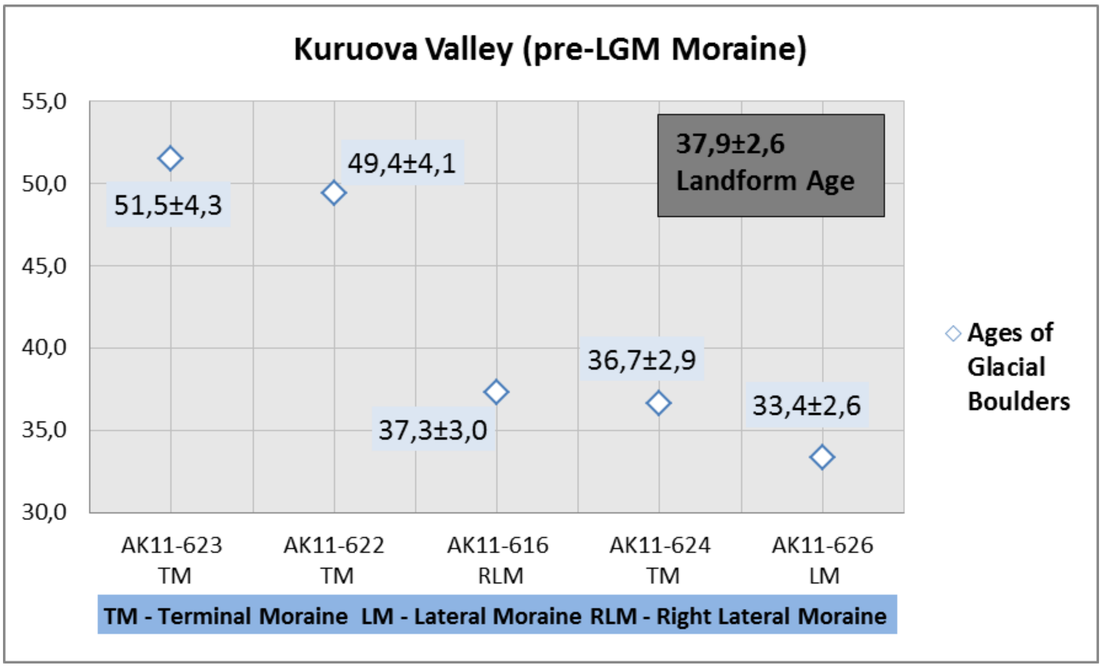


Figure 90. Ages of boulders and age of moraine on Kuruova Valley (pre-LGM Moraine)

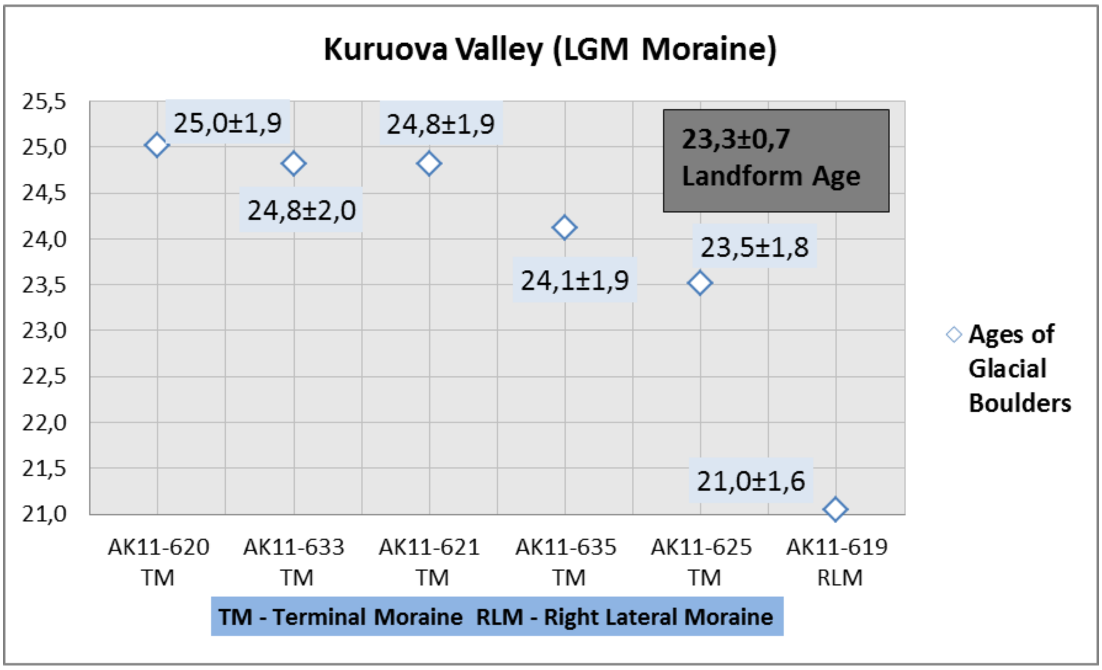


Figure 91. Ages of boulders and age of moraine on Kuruova Valley (LGM Moraine)

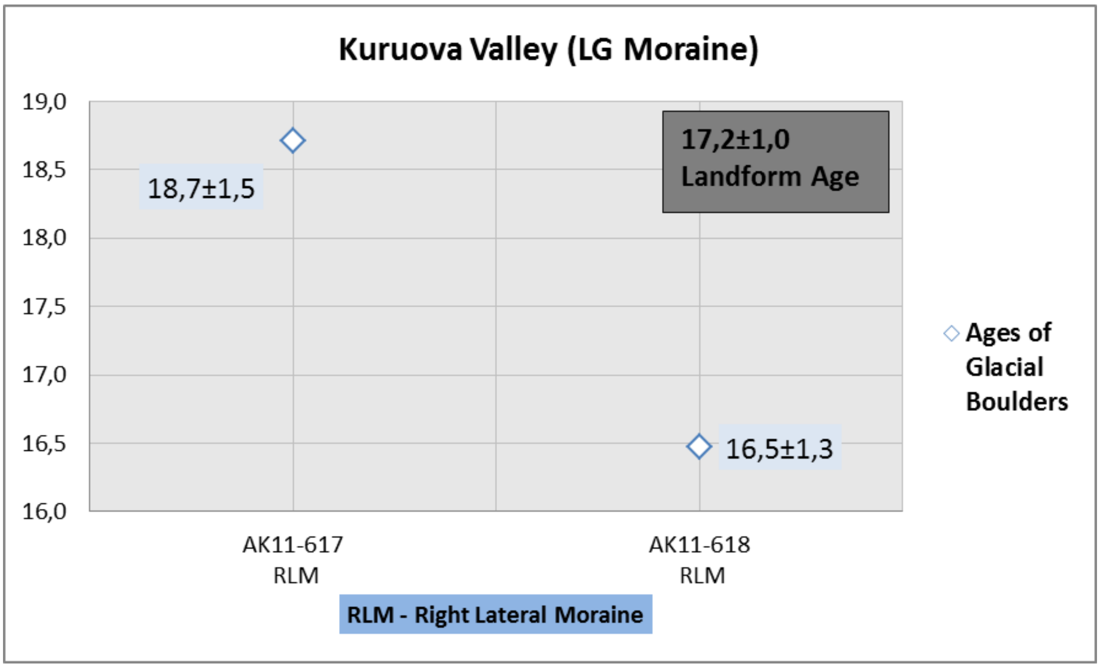


Figure 92. Ages of boulders and age of moraine on Kuruova Valley (LG Moraine)

Five samples were taken from the moraines located at the upper part of Kuruova valley. One sample, out of five, was not included in the calculation of the weighted mean age. The weighted mean age of the moraine’s age was calculated to be 31.8±2.9 thousand years ago. This calculation shows that glaciers moved in pre-

LGM period. The sample's age, which was not included in the weighted mean, was calculated to be 19.4±1.5 thousand year ago and it showed that it belonged to LGM period (Figure 93).

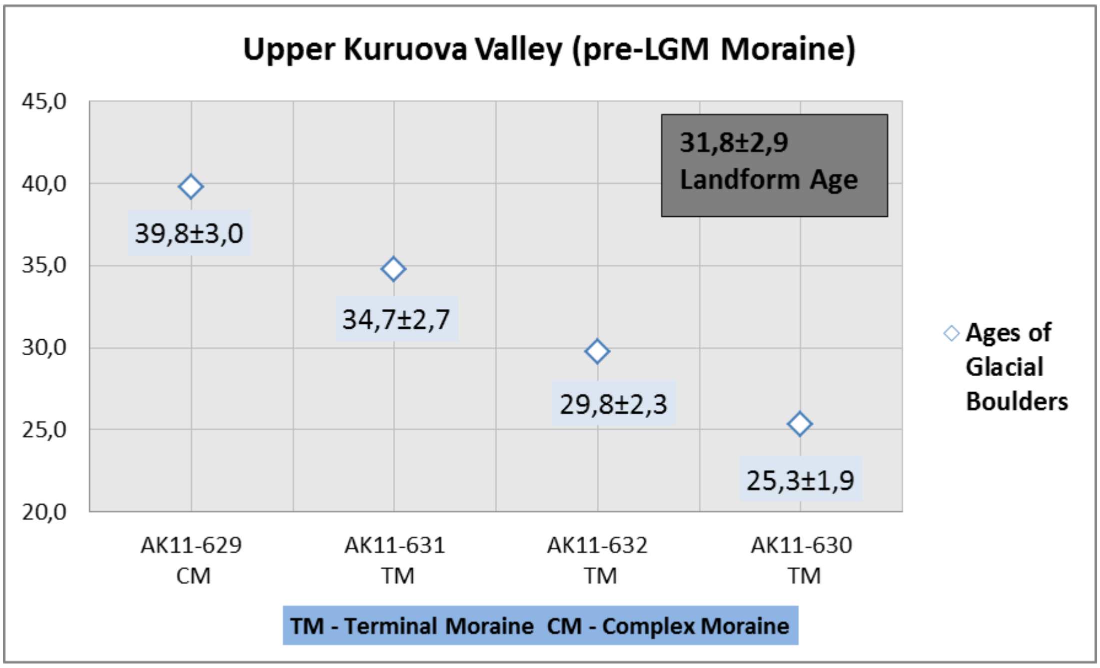


Figure 93. Ages of boulders and age of moraine on Upper Kuruova Valley (pre-LGM Moraine)

4.2. Conclusion of the human activities

Even though transhumance activities, carried out in Akdağ located at Western Taurus, have similar characteristics with transhumance activities executed at other regions of Turkey, some differences are also available. The change of objective of transhumance activities in the past carried out in this region was revealed by this research. While transhumance was mainly carried out with the purpose of raising livestock, it has been used with the purpose of relaxation/recreation in the recent past or today. This is more clearly shown by the study executed. The biggest reason of this is the location of Akdağ. In connection with its location, Akdağ is predicted to be more suitable, by this research, for transhumance activities carried out for the purpose of relaxation or recreation. There are many reasons for this prediction. One of these reasons is Akdağ's proximity to the sea. East of Akdağ falls into the boundaries of Kaş district and its distance from Kaş is 70 km. In the response received to the questions directed at transhumant-people, they stated that they were mainly from the distance of 50-70 km and over 70 km.

Another reason for showing the unsuitability of husbandry is climate. Insufficiency of pastures for husbandry due to climate was stated by transhumant-people. In addition, to the question “if grass cutting is possible” directed at transhumant-people, they replied with the rate of 100%. According to the results, it was determined that transhumance activities, carried out in Akdağ, were more convenient for the purpose of relaxation and recreational activities than for raising livestock. However, traditional transhumance was not completely abandoned. Because, to the question asked in 31 households, 18 households reported that they went up to yayla for the purpose of husbandry.

When looking at the population in the research area, it shows variance according to transhumance areas. While most population is found in İkizgöl, the second most populous place is Taşkuzluklu yayla. Then Subaşı and Kuruova yayla have the population of 18 and 14 respectively. Total population is 114.

When looking at the life satisfaction in yayla, transhumant-people, living in the region, was seen largely to respond in positive way. In the survey conducted in 31 households, 25 of them stated that they were satisfied. Transhumant, living in 5 households, responded negatively. The remaining one household stated that it was indecisive. When looking at the results, it can be concluded that people, living the region, do not have any complaints about living in yayla.

When looking at the regions where transhumance is carried out, it was determined that transhumance activities, for example in Binboğa region, were aimed more at husbandry (Toroğlu and Kılınç, 2008). Even though transhumant-people in the eastern Black Sea, who were examined in another study, are not completely similar to those of Akdağ, they show resemblance with some aspects. When looking at the resemblance, it shows a shift from traditional transhumance, in other words, from husbandry, to tourism transhumance (Şişman, 2010).

Changes can be observed if transhumance’s past in Akdağ and currents developments is examined comparatively. These changes indicate that the understanding of transhumance in the past and that of the present have changed. As a result of this, it is understood that transhumance activities, carried out with the purpose of relaxation, will take place in the future more than the traditional transhumance. Therefore, transhumant-people's purposeful planning for the future will be able to prevent the future occurrence some of the problems.

Akdağ, due to its location, is not far from the holiday resorts. It may be the choice of tourists who would want to escape from the hot weather in summer months. Tourists are more likely to choose Akdağ. In addition, it was seen in the field study that domestic tourists are vacationing in the town of Gömbe, located around yayla, in the months of summer. Gömbe town is approximately 10 km away from the summit of Akdağ. However, the important point is that domestic as well as foreign tourists should be made to this area, which is quite suitable for mountaineering. It is necessary to publicize Akdağ and its surroundings for the realization of this purpose.

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