T. de Meester

Soils of the Great Konya Basin, Turkey

Büyük Konya Havzasının Toprakları, Türkiye

pudoc

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Soils of the Great Konya Basin, Turkey

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Soils of the Great Konya Basin, Türkiye

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Büyük Konya Havzasının Toprakları, Türkiye

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Wageningen

Topraksız bir vatan düşünülemez

Unless we have soil, we have no homeland

K. Atatürk

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Preface

The study of soils in tropical regions has long been part of the curriculum of the Agricultural University in Wageningen. Before the Second World War most attention was paid to the soils of Indonesia, but it was after the War that a rapidly increasing number of students were given the opportunity to specialize more thoroughly in soil science. Many young pedologists worked in countries of all continents. In 1962 a chair for Tropical and Subtropical Soil Science was established. Although many students received a training in tropical and subtropical countries, the need for a special research and training project abroad was felt. For this reason, we highly appreciate the co-operation of the Turkish Government and of many Turkish soil scientists in allowing us to train our postgraduate students in the semi-arid subtropical region near Konya, Central Anatolia, over four consecutive summer seasons (1964–1967) of five months. During winter, research continued at various laboratories in Wageningen.

The outcome of the work has already been recorded in several maps and stencilled reports. The final results are, or are being published in the following papers:

P. M. Driessen & T. de Meester: Soils of the Çumra Area, Turkey (1969).

T. de Meester (Ed.): Soils of the Great Konya Basin, Turkey (this report).

P. M. Driessen: Soil salinity and alkalinity in the Great Konya Basin, Turkey (1970).

B. H. Janssen: Soil fertility in the Great Konya Basin; field-trials and pot experiments (1970).

T. de Meester: Morphological studies on highly calcareous soils in the Great Konya Basin, Turkey (1971).

This report consists of two parts:

A. Reconnaissance soil survey,

B. Results of special studies.

The author of Part A is Ir T. de Meester, who supervised the survey, compiled the maps and keys and wrote the report. The soil survey is based on various detailed soil studies, and detailed and semi-detailed soil surveys in sample areas. In all surveys thorough use has been made of aerial photographs and systematic analysis of aerial photographs. For some paragraphs and chapters, ample use has been made of the preliminary reports of others, in particular on geology (Dr D. J. G. Nota and Mr C. G. E. M. van Beek), vegetation (Mr H. A. de Wit), salinity and hydrology (Ir P. M. Driessen and Mr A. L. van der Linden), soil fertility (Ir B. H. Janssen) and taxonomic classification (Ir J. van den Burg).

Part B contains papers on various subjects by staff and students. Each student received training in field studies, various types of soil surveys and the agriculture-soil relationship but was also allowed to investigate a special subject. Most of these studies were partly in the field and partly in one of the laboratories. They are not always complete and vary in quality. But they contain enough interesting results to justify publication in this form. There are still many subjects that could have been studied but it was thought better to conclude the Konya Project and publish the results.

Acknowledgements

The Konya Project could never have been accomplished without the efficient and very cordial co-operation of the Turkish Government. Much gratitude is due to the Directors General of the Ministry of Village Affairs and the Ministry of Agriculture. We offer sincere thanks to Mr. Naki Üner, Director General of Topraksu and his staff, and to Mr. Mesut Özuygur, Director of the Soil and Fertilizer Research Institute, who was our respected co-ordinator and liaison officer. The Turkish translations are due to him and to Dr Ahmet Mermut.

We will not forget the hospitality of the Directors of our headquarters at the Sulu Ziraat Experimental Station at Çumra, Mr. Dursun Çuhadaroğlu and Mr. Şaban Ermiş.

Dr P. Buringh
Professor in Tropical Soil Science

Önsöz

Tropik bölgelerin topraklarını incelemek ve bu topraklar hakkında ders vermek uzun zamandan beri Hollanda, Wageningen Ziraat Üniversitesinin ders proğramlarında yer almış bulunmaktadır.

İkinci dünya savaşından önce daha ziyade Endonezya toprakları üzerinde durulmuştur. Harpten sonra Wageningen de okuyan öğrenici sayısı süratle arttı ve 1956 yılında öğrenicilere toprak ilmi alanında ihtisas yapma imkânı verildi. Bir çok genç toprak ilmi mensupları her kıt'ada çeşitli memleketlerde çalıştılar. 1962 yılında tropik ve sub-tropik bölgelerin toprakları üzerinde ihtisas yaptırmak üzere tropikal Toprak ilmi için özel bir kürsü ihdas edildi. Her ne kadar tropikal ve sub-tropical memleket toprakları için bir çok talebe özel bir eğitimden geçirildi isede, özel bir araştırma ve eğitim projesine ihtiyaç olduğu anlaşıldı.

Türk Hükumeti ve bir çok Türk toprakcıları ile temin edilen kıymetli iş birliği sayesinde lisans sonrası talebelerimizi Orta Anadoluda bulunan Konya ili yakınlarındaki semi-arid ve sub-tropik bölgede ele alınan bir proje içinde eğitime tabi tutmak imkânı hasıl oldu (Sekil 1).

1964–1967 yılları arasındaki dört yıl zarfinda her yıl yaz ayları esnasında (Tablo 1, bakınız) Wageningen üniversitesi öğretim üyeleri ile içinde Türk öğrenici ve toprak uzmanlarınında bulunduğu çok sayıda lisans sonrası öğrencileri Konya bölgesi topraklarını incelemişler, kış aylarında ise Wageningendeki laboratuvarlarda bu çalışma devam etmiştir. Bu çalışmalardan elde edilen sonuçların bir çoğu ön rapor ve haritalar halinde teksir baskısı olarak yayınlanmıştır. Bütün bu çalışmaların toplam sonucu 1968–70 yıllarında şu sıra ile yayınlanacaktır.

Driessen, P. M. & T. de Meester (1969): Çumra Bölgesinin Toprakları.
Meester, T. de, ve arkadaşları (1970): Büyük Konya Havzasının Toprakları.
Driesen, P. M.: Konya Havzasında Toprak Tuzluluğa ve Alkaliliği, Bölgesel bir etüd (1970).
Janssen, B. H.: Konya havasında Toprak Verimliliği (1970).
Meester, T. de: Konya havzasındaki karbonatlı toprakların oluşumu, morfolojisi ve kullanılması (1971).

Bu rapor iki kısımdan ibarettir.
Kısım A: istikşafi bir toprak etüdü
Kısım B: Bazı özel araştırmaların sonuçları.

Bir çok Türk ve Hollandalı öğrenci genel istikşafi toprak etüdünün yapılmasına katkıda bulunmuşlardır. Bütün bu etüdlerin sevk ve idaresi, lejant ve haritanın tertibi ve raporun yazılması ise kısım A nın yazarı olan Mr. T. de Meester tarafından yapılmıştır. Toprak etüdü, ve haritalama seçilen örnek sahalarda yapılmış olan bir çok detaylı toprak araştırmalarına ,ve detaylı ve yarı detaylı toprak etüdlerine dayanmaktadır. Bütün etüdlerde hava fotoğraflarından ve sistematik hava fotoğrafi analizlerinden yoğun bir şekilde faydalanılmıştır. Bazı paragraf ve bahislerin hazırlanmasında, bazı birincil raporlardan, bilhassa jeoloji üzerinde (Dr D. J. G. Nota, Mr. C. G. E. M. Van Beek), Vejetasyon için (Mr. H. A. de Wit) ve tuzluluk ve hidroloji için (Ir P. M. Driessen ve Mr J. G. van der Linden) ve Toprak verimlikiği (Ir B. H. Janssen) 'in raporlarından istifade edilmiştir.

Kısım B de çeşitli konularla ilgili olarak bu etüde iştirak eden öğretim üyesi ve ögrencilerin bazı araştırma yazıları yer almaktadır. Bilfiil arazi üzerinde çeştili toprak etüd tipleri ve tarım-toprak ilişkileri üzerinde yapılan eğitimden başka, her lisans sonu öğrencisine özel bir konu üzerinde araştırma yapma imkânı verilmiştir.

Bu araştırmaların çoğu arazi ve laboratuvarda yapılan çalışmaların birer parçasını teşkil etmiştir. Bu çalışmalar her zaman tamamlanmış olmadığı gibi aynı kalitede de değildirler. Bununla beraber, yayınlanmaya lâyık değerde ilginç sonuçlar taşımaktadırlar. Halen ele alınmamış incelenmesi faydalı bazı konular da mevcuttur. Bununla beraber bu projeye ait çalışmaları burada bitirip elde edilen sonuçları yayınlamayı tercih ettik. *n*

Teşekkür

Türk Hükûmetinin başarılı ve nazik işbirliği olmadan Konya Projesi çalışmasının tamamlanması mümkün olamazdı.

Köyişleri ve Tarım Bakanlığı Genel Müdürlerine teşekkür borçluyuz. Topraksu Genel Müdürü Sayın Naki Üner ve Arkadaşlarına, çalışmalarımızı koordine eden ve Türk ve Holanda grupları arasında irtibat sağlayan Tarım Bakanlığı Toprak ve Gübre Araştırma Enstitüsü Müdürü, Sayın Mesut Özuygur'a kalpten teşekkür ederiz. Türkçe tercümelerin önemli bir kısmıda onun tarafından yapılmıştır.

Çumra Sulu Ziraat Deneme İstasyonu Müdürleri olan Bay Dursun Çuhadaroğlu ile Bay Şaban Ermiş'in bu müessesede kaldığımız müddet zarfında bize karşı göstermış oldukları konukseverliği unutamıyacağız.

Konya projesinde her hangi bir şekilde katkısı bulunan adlarını zikredemediğimiz diğer bir çok kimselere burada teşekkür ederiz.

Dr. P. Buringh
Tropikal Toprak İlmi Profesörü

Participants in the Konya Project

The Konya Project was carried out under the supervision of Professor Dr P. Buringh, with Ir T. de Meester as the Project Manager and Ir P. M. Driessen as the Team Leader and Instructor in the field. The latter also paid special attention to a part of the Çumra Area, and to salinity research in the Basin.

The following students took an active part in the fieldwork during 1964–1968. C. C. Bannink, P. van Blom, Kadir Gülcan Ahmet Mermut, Gülağa Şimşek and W. van Vuure (parts of the Çumra Area); A. F. Groneman (part of Karapınar Area, Karapınar Camp); W. P. J. Locher (part of Karapınar Area); W. L. Peters (part of Hotamış Area and part of Çumra Area); H. J. Slothouwer (part of Çumra Area and part of Konya Area); C. G. E. M. van Beek and A. L. J. van den Eelaart (parts of Ereğli Area; Ahmet Mermut (part of Hotamış Area, part of Çumra Area, Bor Area); B. J. A. van der Pouw and H. A. de Wit (parts of Karaman Area); J. Melitz (parts of Konya and Hotamış Areas); J. R. Ridders (part of Konya Area) and G. Ruessink (parts of Karaman and Bor Areas).

The student H. A. de Wit made vegetation studies, C. J. G. Winkelmolen carried out salinity researches, and A. L. van der Linden made some hydrological investigations.

Dr D. J. G. Nota executed some geological studies; during a considerable time, Ir B. H. Jansen studied soil fertility, partly together with Mr Nazmi Ülgen. Dr J. van Schuylenborgh visited the field to make some investigations in soil genesis.

Professor Dr İlhan Akalan, Professor Dr Kroontje (USA), Professor Dr van der Kaaden and Professor Dr G. H. Bolt paid short visits to the Project for several purposes.

The project has succeeded in integrating the work of various departments and laboratories of the Agricultural University on a common project. Their work and cooperation is much appreciated. The participants have been the following:

Department of Soil Chemistry, Salinity Laboratory (Ir. C. G. J. Winkelmolen, Miss K. V. Boerwinkel and Miss H. J. van Vliet).

Department of Regional Soil Science, Laboratory for Soil Morphology (Dr Ir S. Slager, Ir J. Bouma, Mr Th. Pape).

Laboratory for Soil Genesis (Dr Ir J. van Schuylenborgh, Miss A. M. van Gemerde, Mr L. T. Beghein).

Department of Geology and Mineralogy (Dr D. J. G. Nota, Dr L. van der Plas, Mr A. T. J. Jonker).

Department of Irrigation (Professor Ir J. Nugteren).

Department of Plant Systematics (Professor Dr H. C. D. de Wit, Dr Ir J. J. F. E. de Wilde).

Drafting has been done by Mr W. F. Andriessen, G. Buurman and F. J. P. Sanderse, the manuscript was typed by Miss Ph. M. Brink, and the photo-reproductions were made by Mr Z. van Druuten.

The maps were drawn up in co-operation with the Soil Survey Institute (Stiboka), Wageningen. The English text was checked, and the typography and layout were supervised by the Centre for Agricultural Publishing and Documentation (Pudoc), Wageningen. Both services assisted in a most pleasant and instructive way.

The Editor

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Part A

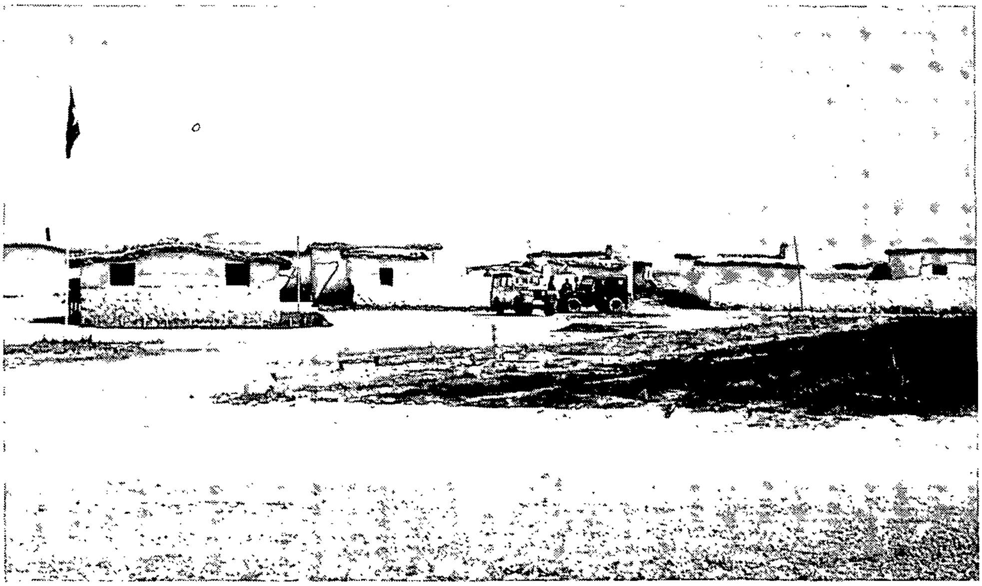
The reconnaissance survey

by T. de Meester

The Experimental Station for irrigated agriculture (Sulu Ziraat Deneme İstasyonu) at Çumra. Headquarters of the Konya Project.

Çumra'da Sulu Ziraat Deneme İstasyonu'nun esas dairesi. Konya Projesinin Karargâhı.

Labourers Camp of the Topraksu Wind Erosion Control Camp (Çiftçi Eğitim Rüzgar Erozyonu Kontrolu Kampı) near Karapınar. Field quarters of the Konya Project.



Karapınar yakınlarında Topraksu Çiftçi Eğitim Rüzgâr Erozyonu Kontrol Kampı. Konya projesinin arazi karargâhı.

1 Introduction

General The great Konya Basin is in the Central Anatolian Plateau at a latitude of 37° and between longitudes 33° and 35° East. In it lies the Provincial Capital of Konya and the towns of Karapınar, Bor, Ereğli and Karaman. It is in the Province of Konya (see Fig. 1). The Basin covers about 1 million hectares (or 2 million acres or 4 million Konya-dönüms) and is enclosed by uplands and mountains which prevent any superficial drainage to the sea. Several rivers flow into the Basin, mainly from the south and the west. The Great Konya Basin will often be referred to just as 'the Basin'.

Having once been a lake, the central part of the Basin is flat and consists of several plains separated by terrain elevations. The most important plains are the Konya Plain, Hotamış Plain, Karapınar Plain, Ereğli Plain and Karaman Plain. These plains are about 1010 m above sea-level. The outer limits of the surveyed area are clearly defined by where the uplands rise steeply from the plain. If the rise is more gradual, an arbitrary limit is set at the 1050 m contour, where agriculture usually becomes marginal through lack of surface soil or rough terrain. Exceptionally the survey has been extended to higher levels (mainly in the east of the area).

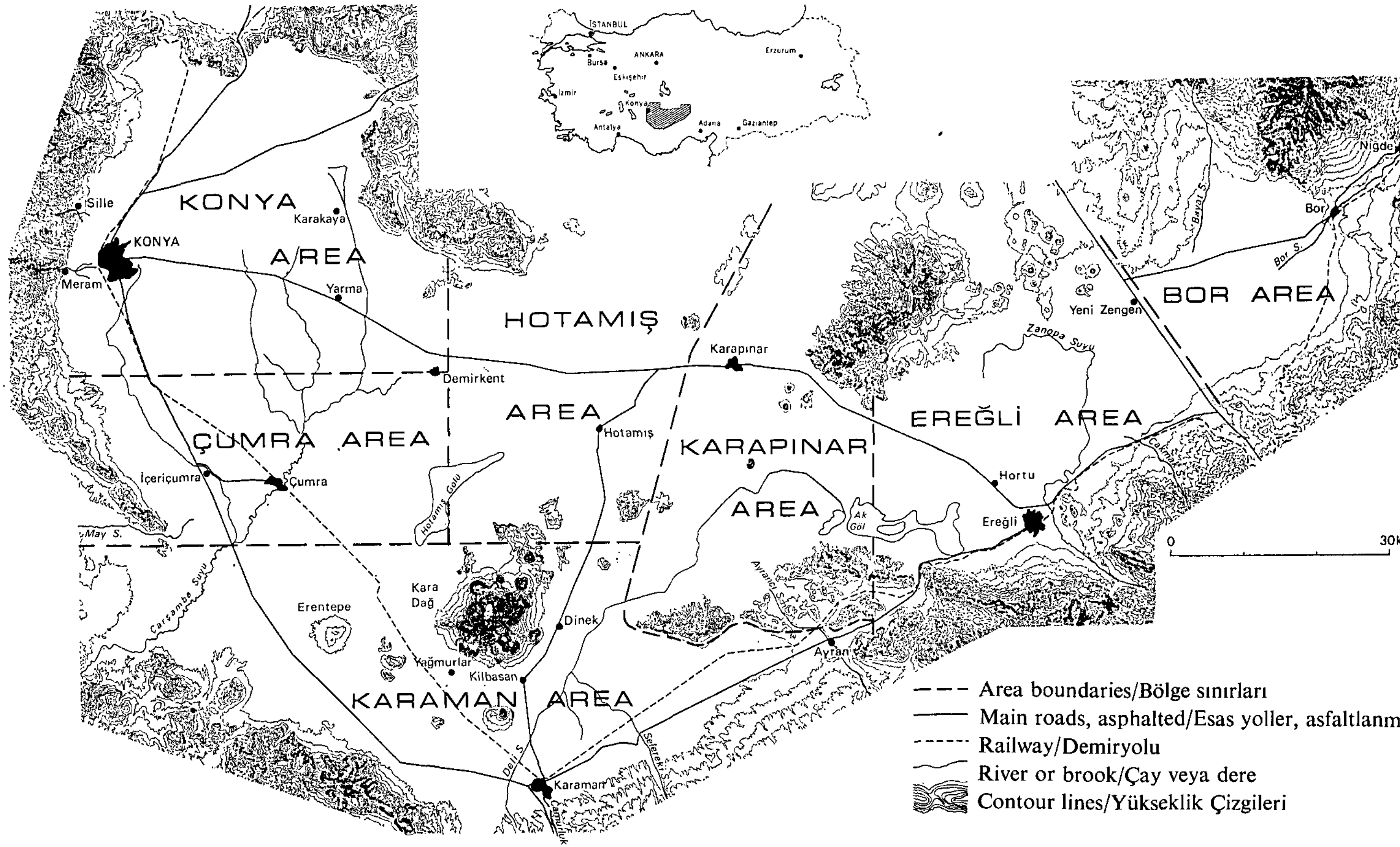
The soil survey is based on many field observations (soil cores and pits) supported by analysis of aerial photographs and laboratory analysis. Especially in the flat areas, poor correlation between photograph and terrain made field work essential for the survey.

The soil survey. Being a reconnaissance survey, the mapping units are at a soil association or soil complex level and only general descriptions are given. But to illustrate their possible components some small sample areas are surveyed in more detail, especially in places considered important for agriculture. Soil profiles have been studied in detail in sample areas from which soil peels were taken for morphological studies and samples were collected for chemical and physical analysis in the laboratory.

Special studies concerned some interesting soil features so that several soil units have been much better studied than others. Some are described in Part B (Results of special studies).

Part A concentrates on inherent soil characteristics. The resulting map is therefore suitable for various applications (e.g. soil suitability, irrigation layout and regional planning). The amount and type of salinization is liable to change with reclamation but has been incorporated in the map as solid and open dots. An attempt has been made to estimate the suitability of each soil unit for 3 different systems of farming. Thence a reconnaissance map of soil suitability has been produced. It ignores many

Fig. 1. General position of the Great Konya Basin, with boundaries of subareas.



Şekil 1. Alt arazileriyle Büyük Konya havzasının genel durumu.

factors, social, economic and technical, which were beyond the scope of the survey. It is based on technical soil data only.

The methods of survey, study and reporting are founded on internationally accepted standards. Wide use is made of the Soil Survey Manual (1951) for soil description and terminology. However, methods used by the Dutch School of soil survey are adopted as well. The soil legend for example is based mainly on a physiographic classification. Fortunately this approach is followed also by the Turkish soil scientists in charge of reconnaissance soil mapping in Turkey.

Subareas. For the readers benefit, the Great Konya Basin is divided into 7 areas, named after the main towns:

Konya Area	Karapınar Area
Çumra Area	Ereğli Area
Karaman Area	Bor Area
Hotamış Area	

The rather arbitrary boundaries of those areas are shown in Fig. 1, which shows the position of some other features as well. More detailed reports and maps of the Çumra Area and much of the Karapınar Area (the Topraksu Wind Erosion Control Camp Area) have been published separately (Driessen & de Meester, 1969; Groneman, 1968). The maps of both areas have been simplified and incorporated in the reconnaissance soil map.

The report and the soil map are complementary. The legend to the soil map is only an indication of the nature of the soil unit; full descriptions are contained in the report.

Prevailing problems. The Great Konya Basin was selected as project area for soil studies mainly because of interesting problems of its soil formation and salinity. Situated at an altitude of about 1010 m, the climate is semi-arid with cold wet winters and hot dry summers. Water supply is limited and the area has no internal drainage, so salinization occurs easily in the lowest spots. But topography and most soils seem favourable for agriculture so that several attempts have been made in the last 60 years to improve agricultural conditions by irrigation, introduction of new methods, of implements and seed. Results have been disappointing. In areas dependent on natural rainfall, the aridity forces the farmer to dry-farming. Fertilizers are rarely used and yields are irregular and poor. The choice of crops is limited by the short growth season.

Irrigated land has more possibilities but inadequate drainage systems and over-irrigation has salinized much irrigated land so that conditions became worse than under dry-farming.

An important factor affecting agriculture is the inherent soil condition, which varies sharply over a short distance and which determines soil capacity for agriculture, irrigated or dry.

This report and related soil studies is therefore expected to be an essentail basis for agricultural development of the Great Konya Basin.

Rapor 2 Büyük Konya Havzası Toprakları

1 Giriş

Genel. Büyük Konya Havzası, Orta anadolu'da yer almış olup kabaca Konya, Karapınar, Bor, Ereğli ve Karaman şehir ve kasabaları arasında bulunur. Havzanın alanı yaklaşık olarak 1 milyon hektardır ($2\frac{1}{2}$ milyon akr veya 4 milyon Konya dönümü). Havza yüksek yerler ve dağlarla çevrili olduğu için denizle bağlantısı bulunan bir dış drenajı yoktur. Bunun aksine olarak, ekserisi güney ve batıdan akan bir çok akar su bu sahaya boşalır. Bu raporda Büyük Konya Havzası adı yalnız 'Havza' olarak geçmektedir.

Eskiden bir göl tabanı olduğu için Havzanın orta kısmı çok düzdür ve birbirinden hafif yüksekliklerle ayrılan bir çok ovadan meydana gelmiş bulunmaktadır. Bunların en önemlileri Konya ovası, Hotamış ovası, Karapınar ovası, Ereğli ovası ve Karaman ovasıdır. Bu ovaların deniz yüzünden yüksekliği yaklaşık olarak 1010 m. dir.

Etüdü yapılan alanın sınırları, ovaya nazaran birdenbire yükselen yerlerde açık olarak belirtilmiştir. Bu yükselmelerin daha az bariz olduğu yerlerde toprak derinliğinin azalması veya topoğrafyanın haşinleşmesi dolayısiyle ziraatin güçleştiği seviye olan 1050 m. den geçen tesviye münhanisi Havzanın takribi sınırı kabul edilmiştir. İstisnai hallerde etüd daha yüksek yerlere kadar teşmil edilmiştir (Özellikle sahanın doğu kesiminde).

Toprak etüd çalışmaları hava fotoğrafları analizleri yardımiyle ve bir çok tarla müşahedelerine (burgu ve çukur açarak toprak muyaeneleri) ve laboratuvar analizlerine istinaden yapılmıştır. Fotoğrafla tarla arasında yeterli korelasyonun bulunmadığı alanlarda arazi çalışması, etüdün yapılmasında başlıca rolü oynamıştır.

Toprak Etüdü. Bu bir istikşafi etüd olduğu için, haritalama birimleri toprak birlikleri veya toprak kompleksleri seviyesinde olup yalnız genel toprak izahları ile yetinilmiştir. Bununla beraber muhtemel kompozisyonlarını ortaya koymak için bir kaç ufak alan 'Örnek alanlar' olarak daha detaylı bir etüde tabi tutulmuştur. Örnek alanlar daha ziyade tarımsal kıymeti yüksek olan yerlerden seçilmiştir. Bir örnek alandan kimyasal ve fiziksel analiz için numuneler alındıktan ve bir toprak monolith'i hazırlandıktan sonra toprak profilinin çok detaylı olarak incelenmesi ve morfolojik araştırmaları yapılmıştır.

Çeşitli maksatlarla bazı ilginç toprak özellikleri üzerinde özel incelemeler uygulanmıştır. Bunun sonucu olarak bazı toprak üniteleri diğerlerinden daha iyi incelenmiş bulunmaktadır. Bunlara II. kısımda 'Özel etüd sonuçları' başlığı altında yer verilmiştir.

Toprak raporunda doğal toprak karakteristiklerinin izahına öncelik verilmiştir. Bunun için bu etüd standart toprak etüdü sınıfına girer. Standart toprak etüdünün özelliği, bu esasa göre hazırlanmış bir toprak haritasının bir çok maksatlar için kullanılabilmesindedir (toprak uygunluğu, sulama işlerinin plânlaması, bölgesel pâlnlama v.s.) Toprak tuzlulaşma derecesi ve tipi (ıslahla değişen bir özellik) toprak lejantında sembollerle gösterilmiştir. Her toprak biriminin üç ayrı amenajman sistemi altında tarıma yugunluk derecesinin tahmin edilmesine çalışılmıştır. Bunun sonucu olarak istikşafi toprak yugunluk haritası meydana getirilmiştir. Sosyal, ekonomik, teknik v.s. gibi bir çok faktörler bu etüdün ĝâyesi dışında kaldığından dikkat nazarına alınmamıştır. Toprak uygunluk sınıflandırması sadece teknik (toprak) donelere bağlı bulunmaktadır.

Toprak etüd, inceleme ve rapor yazma matodları daha ziyade Uluslararası standartlara uymakta olup toprak izahları ve terimlerinde 'Soil Survey Manual' adlı eserden çokca faydalanılmıştır. Bununla beraber aynı zamanda Holanda ekolu toprak etüdlerinde kullanılan metodlara da yer verilmiştir. Meselâ toprak lejant'ı esas itibarile fizyografik klasifikasyona bağlı bulunmaktadır. Memmuniyetle belirtmek lâzımdırki istkşafi etüd yapan Türk toprakcıları da bu sistemi kullanmaktadırlar.

Toprak Alanları. Raporun okunma ve kullanılmasını kolaylaştırmak için büyük Konya Havzası 7 alana bölünmüş ve bunlar şehir ve kasabalara göre şu şekilde isimlendirilmiştir.

Konya alanı	Karapınar alanı
Çumra alanı	Ereğli alanı
Karaman alanı	Bor alanı
Hotamış alanı	

Hudutları, daha ziyade itibari olarak çizilen bu alanlar Şekil. I de görülmektedir. Bu şekilde aynı zamanda diğer bazı özelliklerde işaret edilmiştir. Çumra alanı ile Karapınar alanının önemli bir kısmı (Topraksu rüzgâr erozyon kamp alanı) yarı detaylı bir etüde tabi tutulmuştur. Buralara ait rapor ve haritalar ayrıca yayınlanmıştır. (Gronman 1968, Driessen 1969). Her iki alanın toprak haritaları sadeleştirilerek istikşafi toprak haritasına dahil edilmiştir. Bu iki alana ait fazla bilgi için yukarıda adı geçen raporlara müracaat edilmelidir.

Bu raporla toprak haritası birbirini tamamlıyan iki kısım olarak kabul edilmelidir. Daima beraber kullanılmaları icap eder. Toprak haritasında rastlanan lejant bahis konusu toprak biriminin tabiatı hakkında çok kısa bir işaretten ibaret olup bu toprağın izahı için rapora müracaat edilmelidir.

Önemli problemler. Büyük Konya Havzası bilhassa ilginç olan toprak teşekkülü ve tuzluluğu dolayısiyle proje alanı olarak seçilmiştir. 1000 m. yükseklikte yer alan bu havzanın iklimi, soğuk yağışlı kışlar ve kuru sıcak yazlarla beliren semiarid karekterdedir. Su temini sınırlı ve drenajdan mahrum olan bu sahanın alçak yerlerinde kolaylıkla tuzlulaşma meydana gelir. Bunuula beraber topoğrafya ve toprakların çoğu ziraate elverişli olup bu sebeple son 60 yıl zarfında sulama yeni ziraat metodları, alet ve tohum vererek ziraatı geliştirmek için teşebbüsler yapılmıştır. Bütün bunlardan alınan sonuç pek parlak olmamıştır.

Yalnız yağmura bağlı olan yerlerde kuraklık çiftçileri kuru ziraat sistemi tatbik etmeğe zorlamıştır. Genellikle gübre kullanılmamaktadır. Mahsul kararsız ve düşüktür. Kısa büyüme mevsimi dolayısiyle yetiştirilen mahsul çeşitleri sınırlıdır.

Sulama tatbik edilirse imkânlar artmaktadır. Fakat yetersiz drenaj sistemi ve lüzumundan fazla su verilmesi sulanan sahaların bir kısmını tuzlu bir duruma sokmuştur. Buralarda kuru ziraat şartlarına nazaran daha fena mahsul elde edilmektedir.

Ziraate etki yapan önemli bir faktör de tabi toprak şartları olup kısa mesafeler içinde değişir. Bu faktör toprağın kuru veya sulu ziraat kapasitesini tayin eder.

Bu düşüncelerle bu toprak etüd raporunun ve buna ait diğer araştırmaların Büyük Konya Havzası tarımının gelişmesinde geniş ölçüde katkıda bulunacağı beklenebilir.

2 Physical environment of the Basin

2.1 Geology

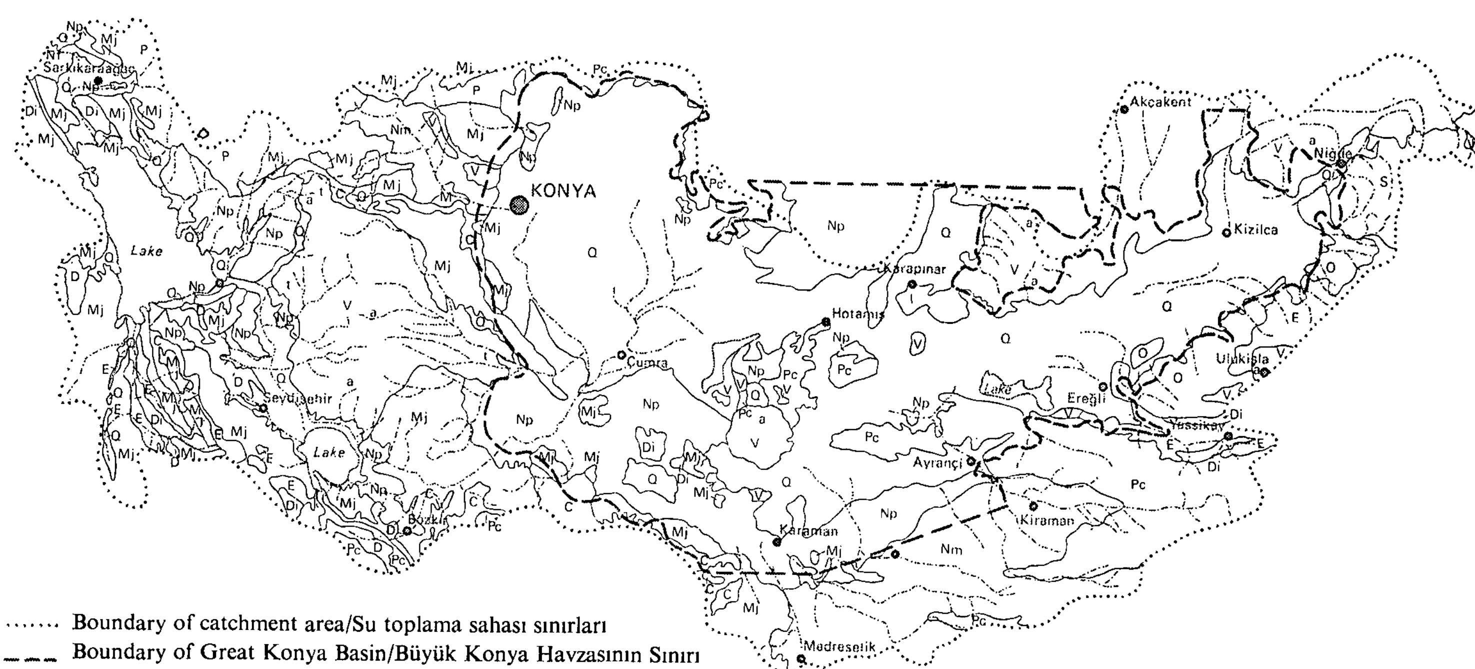
The Great Konya Basin has a large catchment area, in particular at its western and southern side. Material eroded from the uplands has entered the Basin since the Tertiary Era; consequently some knowledge of their geology is important for the understanding of sediments and soils of the Basin itself. Position and geology of the Basin and its catchment area are shown in Fig. 2. The great Konya Basin is part of the Central Anatolian Plateau, which is bordered in the North by the Pontic mountains and in the South by the Toros range.

Toros Range. The Toros Mountains consist of marine sediments formed until the Miocene Era (Ketin, 1966). In the Upper Cretaceous, intrusions of basic material are formed, which occur mainly south of Ereğli. The intrusions consist locally of Peridotite or Serpentine. After intrusion, alpine folding started. Several phases can be distinguished. During the Oligocene folding was most active. As a result Palaeozoic sediments occur locally as metamorphic rock, for instance south of Ereğli uplift started during the Miocene and has continued. Marine sediments can be found south of Karaman more than 1000 m above sea level.

Central Plateau. The Central Anatolian Plateau is a stable massif consisting of a continuous series of sediments up to the Upper Cretaceous. Most of these sediments are limestones. Metamorphic rock occurs along the eastern border of the Konya Area. Volcanic deposits, and ultrabasic and basic rock (mainly Serpentine) from the period of alpine folding have covered the massif as can be seen 10 km south west of Konya (near Hatip) and some 16 km south-east of Çumra (the isolated Erentepe).

The Lower Eocene sediments lie unconformably on an older formation. They consist of thick Flysch sediments, lavas and tuffs. The Upper Eocene, Oligocene and Miocene are deposited either in dry condition or in a lake. Sediments of salt and gypsum occur in the Central Plateau and in the Great Konya Basin, about 3 km North east of Ereğli. The Mio-Pliocene (= Neogene) formation consists of hard limestone deposited in fresh water. It is mostly horizontally stratified but locally slightly inclined, due to some uplifting of the Toros Massif. A large proportion of the Great Konya Basin is covered by these Neogene limestones marked as 'Terraces' on the soil map. Along the border of the Basin Neogene conglomerates occur locally, like those 24 km north of Konya and about 25 km east-north-east of Ereğli.

Fig. 2. Geology of the Basin's catchment area (simplified from the Geological map of Turkey 1 : 800.000).



...... Boundary of catchment area/Su toplama sahası sınırları

__ __ Boundary of Great Konya Basin/Büyük Konya Havzasının Sınırı

._._._ River or brook/Çay veya dere

Şekil 2. Su toplama havzasının jeolojisi (1 : 800,000 ölçekli Türkiye Jeolojik haritasından sadeleştirilmiştir.)

Q Quarternary/Kuaterner
(mainly alluvial and lacustrine calcareous clays)
(genellikle alluvial ve lakustrin kireçli killer)

Np Neogene/Neojen
(mainly Pliocene horizontally stratified freshwater limestone)
(genellikle pliosen, yatay olarak birikmiş tatlı su kireç katları)

Nm Neogene/Neojen
(mainly Miocene marine limestone)

O Oligocene/Oligosen
(mainly gypsum or soluble salts)
(genellikle jips veya çözülebilen tuzlar)

E Eocene/Eosen
(mainly calcareous Flysch deposits)
(genellikle kireçli fliş yığıntıları)

Mj Mesozoic/Mesozoik
(mainly Jurassic and Triassic limestone)
(genellikle Jurasik ve Triasik kireçtaşı)

C Cretaceous /Kretase
(mainly marls with Serpentine and radiolaries)
(genellikle serpantin ve radiolaritli marnlar)

P Palaeozoic/Paleozoik
(mainly marmor)
(genillikle mermer)

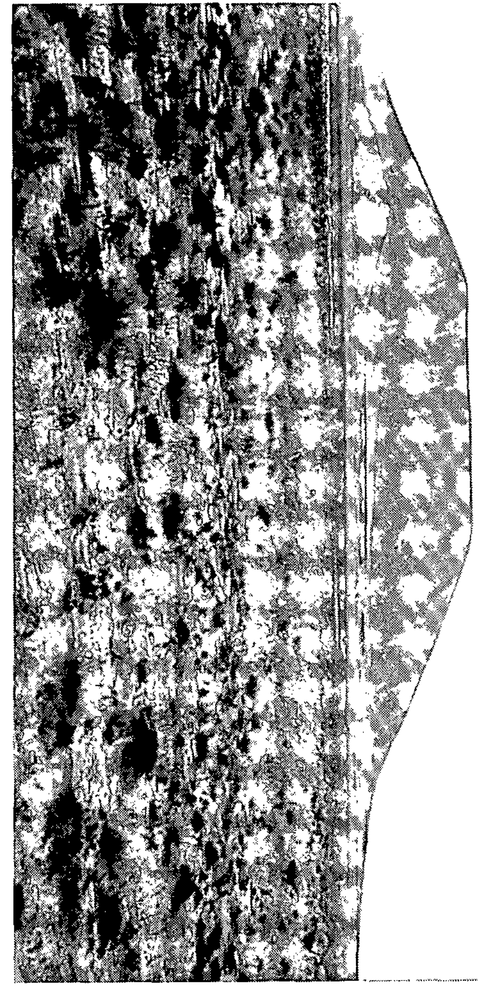
PC Permocarboniferic/Permokarboniferli
(mainly limestone and marmor)
(genellikle kireçtaşı ve mermer)

D Devonic/Devonik
(mainly stratified limestone)
(genellikle tabakalı kireçtaşı)

S Chrystalline Schist/Kristalin şist

DI Diorites/Dioritler

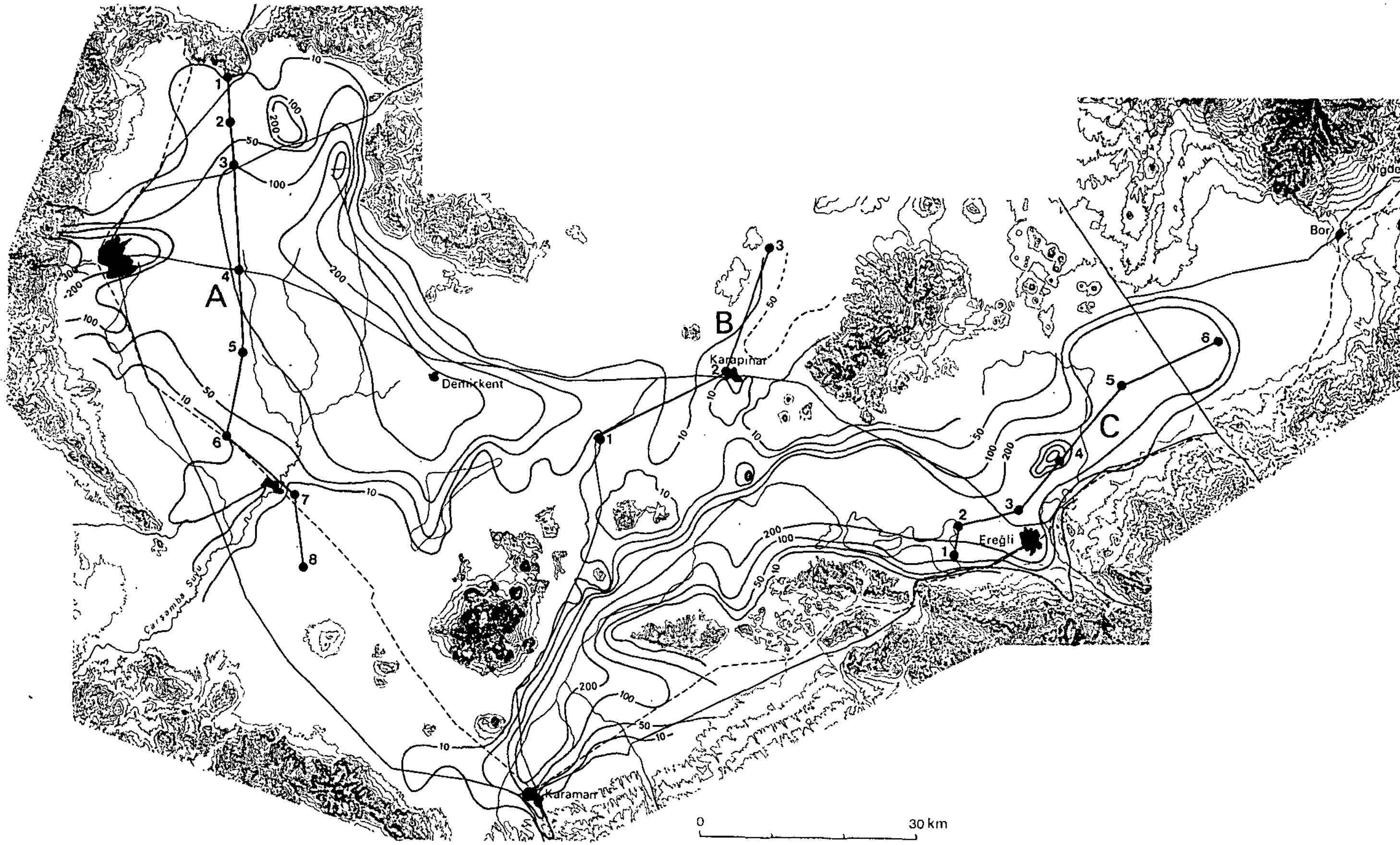
V Volcanic deposits/Volkanik birikintiler
- a mainly Andesit and Dacit
  genellikle andezit ve dasit
- b mainly Basalt
  genellikle bazalt
- t mainly Tuff
  genellikle tüf
- 11 mainly quarternary lava
  genellikle Kuaterner lav



Şekil 3. Karapınar Mekke dağının volkanik konisi (UvB ünitesi). Ayağındaki dikliğe dikkat ediniz. Ön plânda hafif tümsekli mikrorölief'e sahip LpC ünitesi. Genellikle vejetasyon *Peganum harmala* (üzerlik).

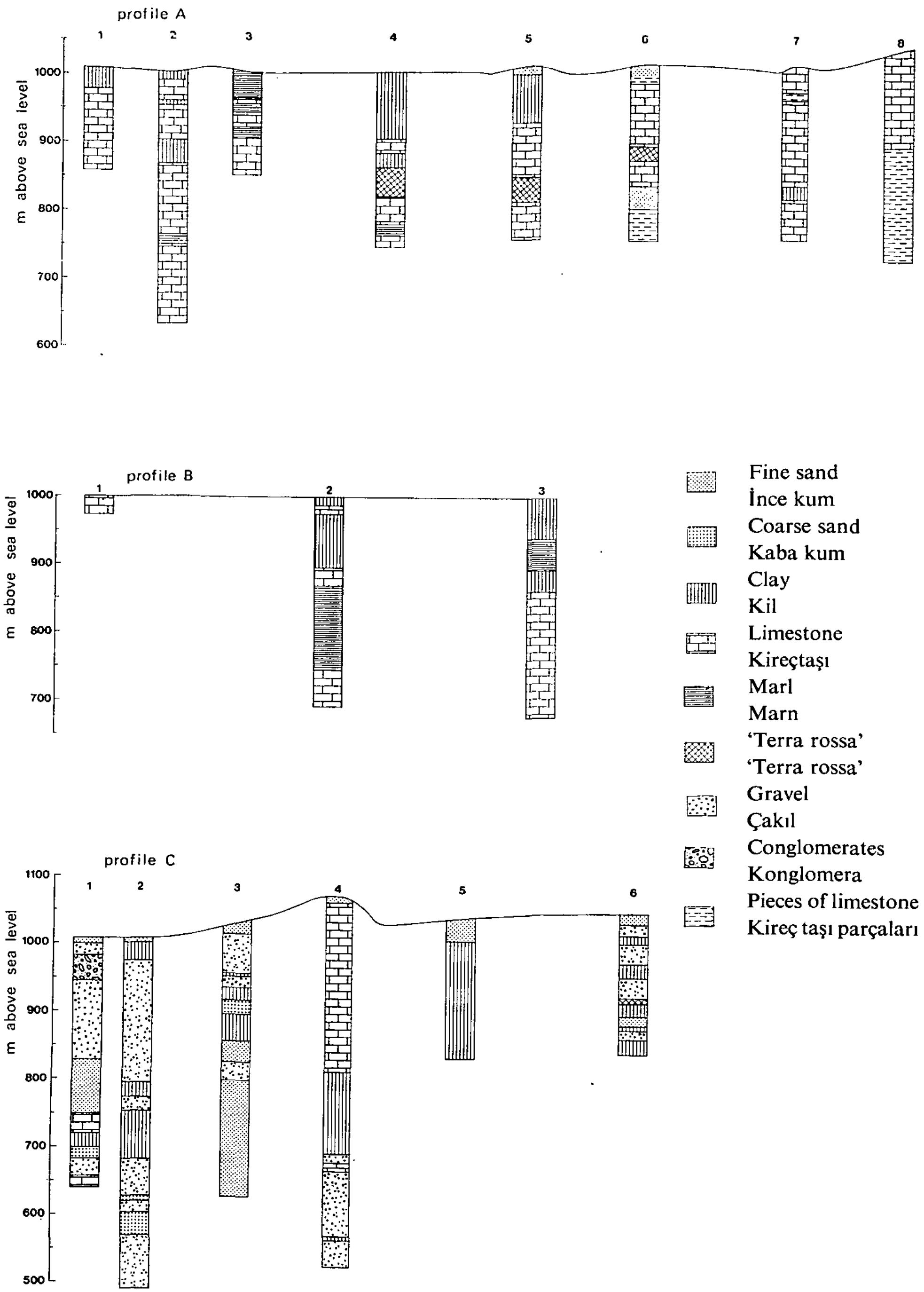
Fig. 3. Volcanic cone (unit UvB) of Meke Dağ, Karapınar. Note the cliff at its foot. In foreground unit LpC with slightly hummocky microrelief. Vegetation mainly *Peganum harmala*.

Fig. 4. Approximate depth of the limestone substrate in the Basin. Derived from DSİ data of deep borings for wells, and after Watermanagement studies (1965).



Şekil 4. Havzanın alt katlarındaki kireç taşlarının Yaklaşık olarak derinlikleri. DSİ derin kuyularına ait kayıtlar ve Watermanagement studies (1965).

Fig. 5. Schematic data from 17 borings. The position of the borings is shown on Fig. 4.



Şekil 5. 17 Burgudan elde edilen şematik bilgiler. Burguların yapıldığı yerler şekil 4 te gösterilmiştir.

Volcanism. Alpine folding stopped gradually during the Miocene. In that area volcanic activity started again, presumably first near Konya (Westerveld, 1957). The earlier volcanic deposits consist of acid tuffs. Afterwards volcanic deposits, consisting of andesitic and, later, basaltic material were produced south-west of Konya, at Karadağ and near Karapınar. Also near Karapınar there are some young volcanoes, such as Meke Dağ (Fig. 3).

The Basin. The Great Konya Basin is a structural basin filled with different Tertiary and Quaternary sediments. Most of the sediments come from the surrounding mountains which, as is described above, consist of Palaeozoic and Upper Cretaceous limestone. Tertiary volcanic rocks consisting mainly of andesite, dacite, diorite and tuff are found all along the Basin's border, but mainly along the eastern half (Karapınar, Ereğli and Bor areas).

According to scanty data from borings of deep wells (Water management, 1965), the sediments which fill the Basin are more than 400 m thick locally in the Konya Area and consist of clastics, such as clay, marl, sand, gravel and conglomerates and hard Neogene fresh water limestone, often intercalated with soft lime. Thick layers of calcareous clay occurred between limestone strata.

The limestone outcrops at several places along the border of the Basin and in the actual Basin but it generally dips under the plain, where it is found at various depths (Fig. 5). The pattern in the Konya and Çumra areas is taken from de Ridder (1965), a supplementary sketch for the other areas is based on far fewer data.

Some of the rivers enter through valleys incised into the limestone. These valleys probably formed when the lake was low during the early Pleistocene. The clastic sediments are very thick there. Fig. 5 shows seventeen schematized well-logs from sites scattered over the entire Basin (sites are indicated in Fig. 4). An interesting observation from the borings in the west is the occurrence of red clays, interbedded in limestone, mostly at a depth between 100 and 200 m. Red clay is usually a weathering product of limestone. These colluvial red clays are evidently erosion products of surrounding limestone hills and observed at the surface of the Basin near its fringes (Bajadas in Chap. 5.5). Presumably the deeper red clays are also products of weathered limestone which were here and there carried far into the centre of the Basin, while elsewhere lacustrine sedimentation of lime continued (de Ridder, 1965).

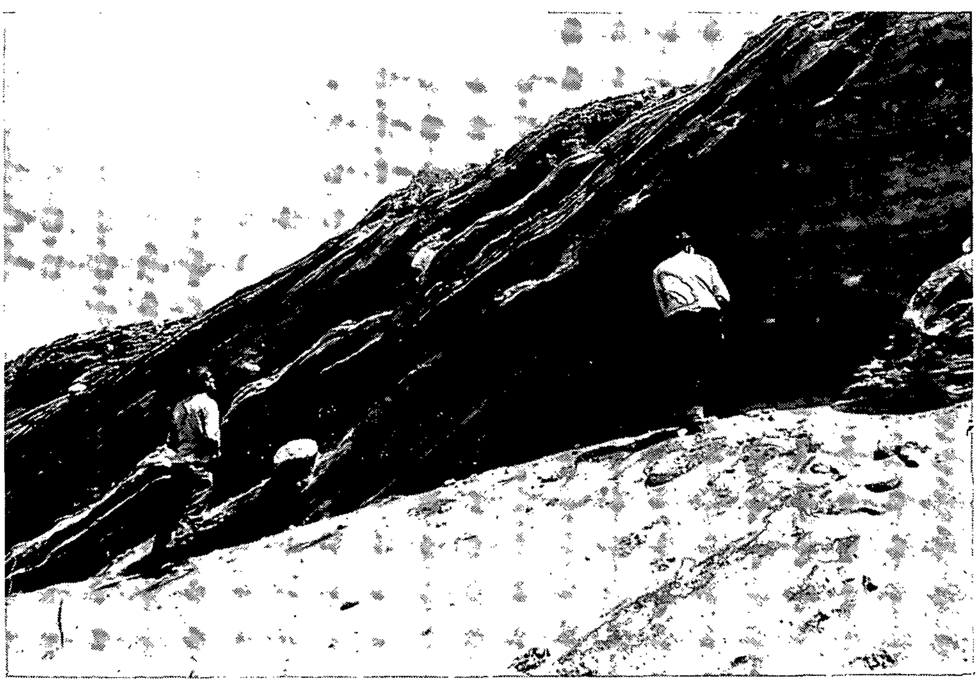
The upper sediments 10–50 m thick are Recent (Quaternary). They include the most of the parent material of the mapped soils. There is evidence that a large, rather shallow lake, Ancient Lake Konya, existed during the Late Pleistocene (Louis, 1938; Lahn, 1946). Unlike the neighbouring Lake Burdur, the level of the pre-historical Konya Lake must have been fairly constant, because of a number of shore deposits at almost the same level. Presumable during the Würm Period precipitation must have been less than evaporation and subsoil drainage and the lake dried up. Its dry floor, shores, and alluvial and colluvial sediments which have spread into the Basin, give the landscape its present form and determine the nature of the soils. The geomorphology of this surface will be described next.

2.2 Geomorphology

The Basin fringes. The Great Konya Basin is surrounded by uplands, mainly limestone and volcanic rock. The uplands along the northern and southern fringe consist of folded metamorphic (Tertiary) limestone, reaching 1500 m. The higher parts are entirely denuded of soil and are hilly. The footslopes consist of colluvium and sometimes of alluvial Piedmont plains or bajadas as defined by Thornbury (1965). The Neogene freshwater limestones which here and there border the Basin or cover it (Fig. 2), are horizontally stratified or dip slightly towards the Basin. These formations, locally in combination with faults, form structural terraces. They reach about 1050 m and are there undulating through dissection by erosion, the lowest limestones are at basin floor level (1000 m) and have a flat surface. Karstic phenomena occur abundantly in Tertiary limestone. Sinkholes (dolines) are restricted to zones. There are many springs along the Basin's limestone fringes.

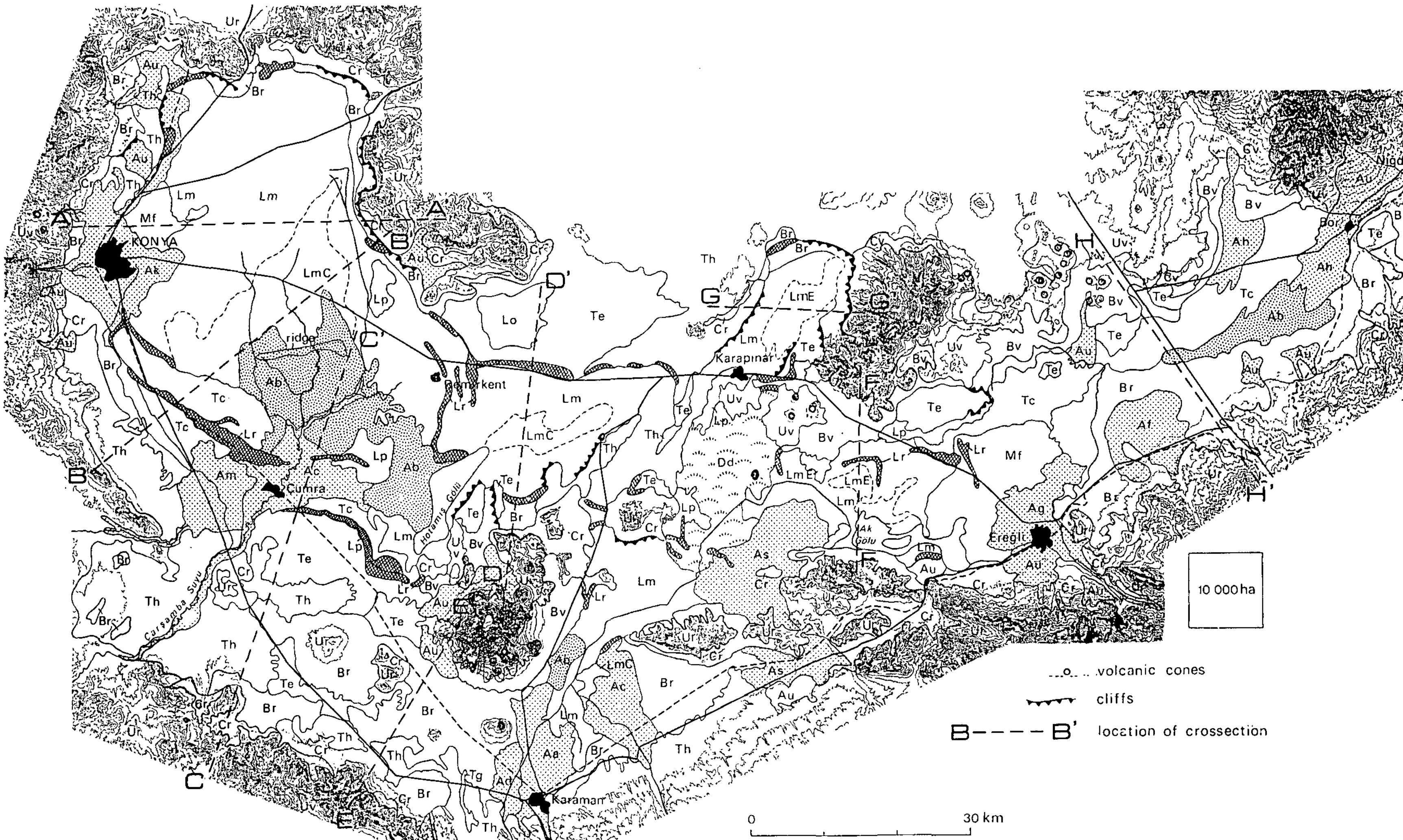
West of Ereğli and north of Konya Neogene conglomerates occur. These parts are hilly or undulating. Erosion of the limestone uplands has caused many small or large dry gullies or small stream valleys. The larger ones were evidently shaped in the Pleistocene. Most of them open out into small alluvial fans, sometimes several fans

Fig. 6. Volcanic tuff layers near Krater Göl (unit UvA) Karapınar Area.



Şekil 6. Karapınar yöresinde Krater Göl (UvA ünitesi) yakınlarında volkanik tüf katları.

Fig. 7. Soil association map and position of cliffs.

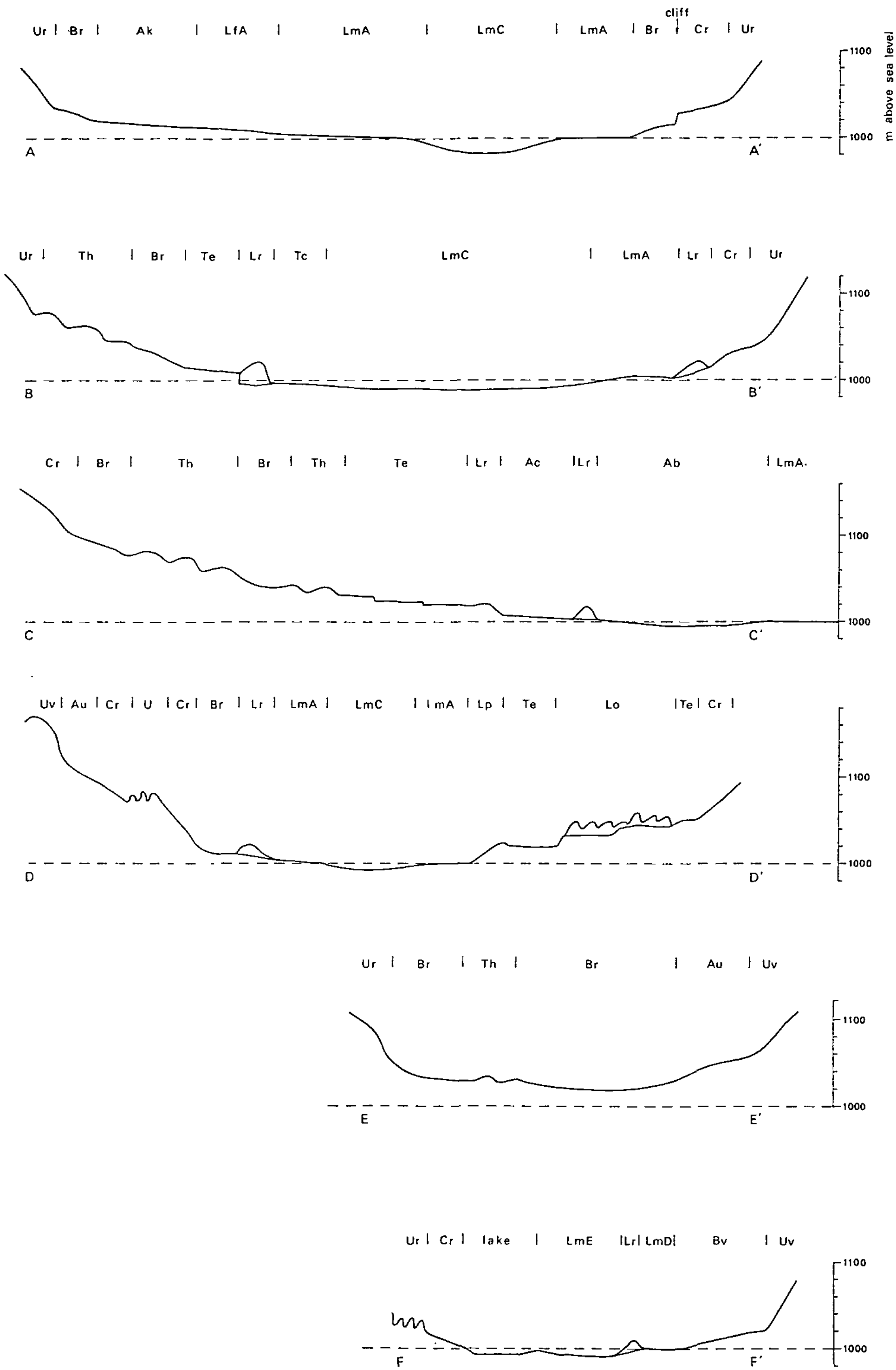


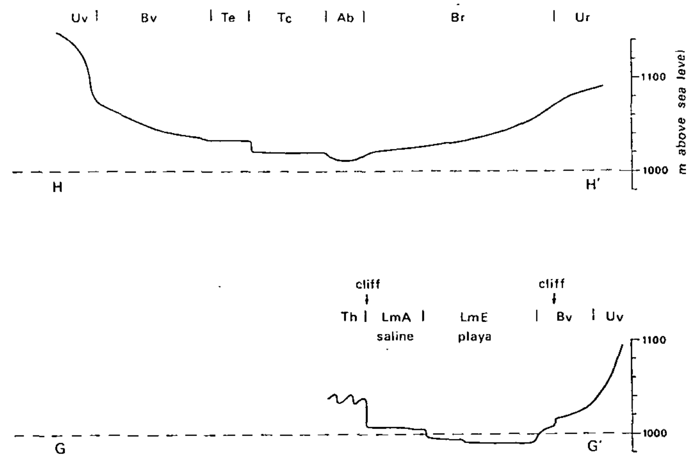
Şekil 7. Toprak birlikleri haritası ve dik eğimli kenar arazilerin yerleri.

Fig. 7. Legend
Lejant

Ur Limestone Upland Soils
Ur Kalkerli yüksek arazi toprakları
Uv Volcanic Upland Soils
Uv Volkanik yüksek arazi toprakları
Cr Limestone Colluvial Soils
Cr Kolloviyal topraklar (Kalker kökenli)
Cv Volcanic Colluvial Soils
Cv Kolloviyal topraklar (Volkanik kökenli)
Te Flat Terrace Soils
Te Düz teras toprakları
Th Undulating Terrace Soils
Th Ondüleli ve bölünmüş teras toprakları
Tc Soft Lime Soils
Tc Yumuşak kireçli topraklar
Br Limestone Bajada Soils
Br Bajada toprakları (Kalker orijinli)
Bv Volcanic Bajada Soils
Bv Bajada toprakları (Volkanik menşeli)
Aa Çamurluk Fan Soils
Aa Çamurluk nehri yelpazesi toprakları
Ab Former Backswamp Soils
Ab Eski bataklık ardı toprakları
Ac Çarşamba Fan Soils
Ac Çarşamba nehri yelpazesi toprakları
Ad Deli Fan Soils
Ad Deli nehri yelpazesi toprakları
Ae Selereki Fan Soils
Ae Selereki nehri yelpazesi toprakları
Af Çakmak Fan Soils
Af Çakmak nehri yelpazesi toprakları
Ag Zanopa Fan Soils
Ag Zanopa nehri yelpazesi topraklari
Ah Bor Fan Soils
Ah Bor nehri yelpazesi toprakları
Ak Meram and Sille Fan Soils
Ak Meram ve sille nehri yelpazesi toprakları
Am May Fan Soils
Am May nehri yelpazesi toprakları
An Bayat Fan Soils
An Bayat nehri yelpazesi toprakları
As Ayran Fan soils
As Ayrançı nehri yelpazesi toprakları
Au Soils of Medium Sized Fans
Au Orta büyüklükte nehri yelpazesi toprakları
Lm Marl Soils
Lm Marn toprakları
LmC with organic surface
LmC sığ koyu gri organik satıh toprağı
LmE with salt crust on surface
LmE Playa'lar. Çok tuzlu, kireçli, toprak, zaman zaman su baskınına maruz,
Lr Sandridge Soils
Lr Göl kenarı toprakları
Lp Sandplain and Beach Soils
Lp Kum düzlükleri ve plaj toprakları
Lo Old Sandplain Soils
Lo Eski kum düzlüğü toprakları
Mf Marsh Soils
Mf Bataklık toprakları
Dd Sand Dunes
Dd Hareketli ve sabit kumul'lar

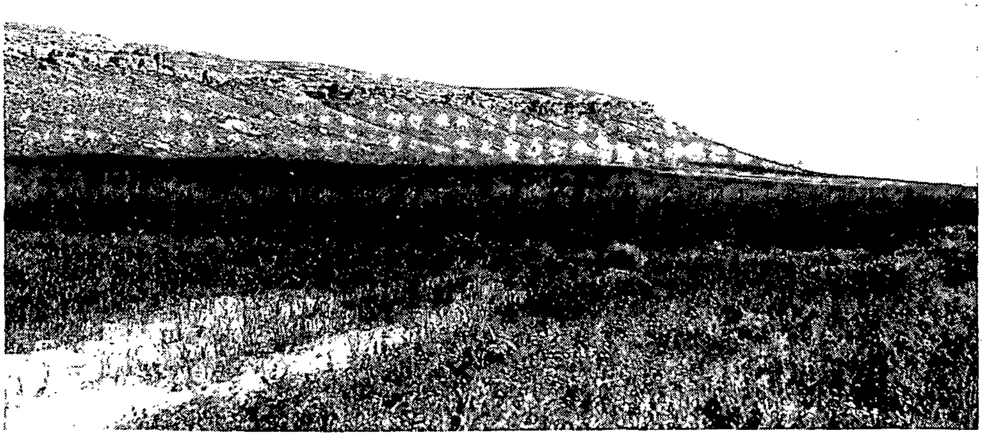
Fig. 8. Schematic sections of the Basin, showing position of soil associations. See the soil association map (Fig. 7) for the position of sections A to H.





Şekil 8. Toprak birliklerinin yerlerini gösteren havzanın şematik bölümleri. A dan H ya kadar bölümlerini gösteren toprak birlikleri haritasına (şekil 7) bakınız.

Fig. 9. Neogene structural terrace (TeC) with cliff escarpment towards the Lacustrine Plain in the Hotamış Area. In foreground transitional zone with LmA soil, a fallow field, then a wheat field.



Şekil 9. Hotamış yakınlarında lakustrin ovaya doğru dik kenar eğimlere sahib Neojen strüktürel teras (TeC). Ön plânda LmA ünitesine geçiş bölgesi, bir nadas arazi, ondan sonra buğday tarlası.

coalesce to form a broad fluvial Piedmont plain or bajada stretching into the Basin. Several large streams, some permanent, some intermittent, disgorge into the Basin, mainly from the south, west and east. Their large alluvial deposits of various shapes will be discussed later. The volcanic uplands surround the Basin mainly in the east (between Karapınar and Bor) and near Konya. Near the centre of the Basin, the volcanic Kara Dağ rises like a large island from the plain to a height of 2900 m. There are several smaller isolated volcanoes south of Karapınar. The higher parts of the volcanic uplands are usually very irregular and mountainous in topography. Their footslopes are smooth-sloped and often consist of permeable ash and pumice, locally redeposited as colluvium or bajada. Nicely shaped cones occur near Konya south of Karapınar (Fig. 3) and west of Bor. Near Karapınar there are several craters of the Maar type now filled with water; around them are thick deposits of stratified volcanic tuff (Fig. 6). According to Westerveld (1957) several volcanoes in this area have been active until historical times. The perviousness of the volcanic deposits along the Basin's border has prevented water from eroding so many erosion gullies.

The Basin floor. The Great Konya Basin is entirely filled with clastic sediments. Apart from the colluvial slopes, which we have taken as part of the uplands, the surface of the Basin is given its present shape by recent alluvial and lacustrine sediments, and locally by structural terraces. This surface or floor, being very flat and level, is commonly called the Konya Plains or in Turkish Konya Havzası, in the litterature. Remnants of shorelines, evidence for the existence of a Pleistocene Lake are found all over the area, especially between the 1010 and 1020 m contours. The sandy and gravelly beaches, and sandridges are multifarious: barrier spits as between Kasınhanı and Fethiye, bay barriers as near Çarıklar and Kayaçık, tombolos near Egribayat, cuspate forelands as around Kara Dağ and bars as south-east of Konya. Steep cliffs are still to be seen at several places along the border, in particular where the uplands rise steeply from the plain, as near the northern and eastern borders of the Konya Area and east of Hotamış Gölü, between Çumra and Hotamış area. Fig. 7 shows existant ancient beaches, sandridges and cliffs; the soilmap shows them in more detail. See also Figs. 8 and 9.

Louis (1938) describes clear abrasion phenomena near Karapınar (Fig. 3). Similar features can be seen very clearly in the cliffs east of Karakaya (east Konya area).

The bottom of the former lake occupies an extremely flat area in the lowest and central part of the Basin. This plain has soils of lacustrine carbonatic clay or marl. Originally it occurred all within the 1017 m contour but in places it has been covered by alluvial sediments so that the marl soils are now limited to most of the Hotamış Area and parts of the Karapınar and Ereğli Areas. A small marl plain is found in the north-east of the Karaman Area. The plain has slight depressions in the Konya, Hotamış, Karapınar and Ereğli Areas which used to contain or still contain marsh or open water. Hotamış Gölü and the Ak Göl could be considered as last remnants of the Ancient Lake Konya.

From the uplands around the Basin many stream channels enter the plain, especially from the mountains in the south-west and south. Where the stream enters, sediment fans out in an alluvial fan. Much of the former lake bottom is covered by alluvial fans, mainly from the rivers Meram near Konya, May and Çarşamba near Çumra, Çamurluk near Karaman, Ayran near Ayrancı, Zanopa near Ereğli and the Bor-river near Bor (See Fig. 7). The type and size of the fan and the nature of its soil is directly related to the size, the present and past climates, and the geology of the river's catchment area. Figs. 2 and 62 show the catchment area of the entire Basin. These maps show that it extends mainly to the high mountainous area south and south-west of the Basin. The River Çarşamba has the largest catchment area of all rivers and its deposits in the Basin cover the largest area. The shape and nature of the deposits (levees and backswamps) suggest that it is rather a delta than an alluvial fan. It is nearly flat and slopes slightly towards the centre of the Basin. The alluvial fans of the other rivers are more irregular, dissected by many deserted or active channels, several of which are now used as irrigation ducts. Characteristic are the lobate masses of debris which have collected in the upper parts of many fans. A transition between colluvial and alluvial soils is formed by the piedmont plains, or bajadas (Thornbury, 1965). Those deposits are flat and nearly level, and occur as a 2 to 3 km wide belt along the foot of the limestone and volcanic uplands. They seem to have been formed by mass-transport of weathering products over short distance from the uplands to the Basin (de Meester & van Schuylenborgh, 1966 and in Part B). Bajadas from limestone occur mainly between Konya and Karaman and also between Ereğli and Bor (southern border), volcanic bajadas between Karapınar and Bor (northern border). It is sometimes difficult to distinguish colluvial slopes from bajadas in particular because there are differences in interpretation of the term colluvium in textbooks of geomorphology and soil science. We have used the terminology of Thornbury rather than the Soil Survey Manual (1951). He defines colluvial as transported mainly by gravity and alluvial and fluvial as transported mainly by water. The described bajadas are considered transitional because their soils are less stratified and less well sorted than soils of alluvial fans. This sort of deposit is typical for semi-arid areas. East of Ereğli is a bajada system, consisting of gravels, presumably deposited earlier (Neogene). They are deeply incised by temporary streams and by gullies. Clayey or loamy bajadas at the foot of the former ones, are clearly developed from redeposited old bajada material. Other evidence about the difference in age is discussed later. At the upper edge of the bajadas and also at other places where the Basin is bordered by steeply rising uplands are many small fans of debris in which ever changing channels run out radially. They consist of angular cobbles or (at their base) gravel from either limestone or volcanic material.

Aeolian windblown deposits occur in a few places. The largest area with shifting and fixed sand dunes is south of Karapınar. Smaller areas are east of Karkın, north-east of Yarma and along the Ak Göl depression (western Ereğli Area). The dunes near Karapınar are partly fixed by natural vegetation, partly still shifting. Most are crescent-shaped (barkhans) and 8 to 10 m high.

A peculiar type of aeolian deposit is small areas with dunes or hummocks of pseudosand, i.e. sand-sized grains of clayey texture. There are pseudosand dunes near Alemdar, west of Hotamış Gölü and at several other places, mainly in saline areas where they originate. Their origin will be explained later.

Structural terraces. Vast areas within the Great Konya Basin consist of plateaus at slightly different levels from 1000 to 1070 m. Those areas, belonging neither to the fringes nor to the Basin floor, are structural terraces of horizontally stratified Neogene limestone. They occur mainly in the south of the Çumra Area, the north of the Hotamış area and the north-west of the Ereğli area. The various levels, often separated by escarpments, are presumably due to subsidence or uplift along faults and not to abrasion along ancient shores of the lake as was presumed by de Ridder (1965). The terraces occurring above 1010 m are generally covered by shallow alluvial deposits or residual material. Those from 1020 m upwards are increasingly affected by sheet and gully erosion, eventually resulting in an undulating topography above 1030 m.

Physiographic units. Summarizing, the surface of the Basin may now be divided in physiographic units which are listed below in the order used in the soil map's legend.

1. *Uplands*: limestone and volcanic formations around the Basin irrespective of height or shape.
2. *Colluvial Slopes*: strips or areas of rock debris, or stony and cobbly soil, or volcanic ash at the foot of the Uplands.
3. *Terraces*: horizontally stratified neogene limestone plateaus, forming structural terraces at various levels the higher ones being dissected by gullies. They include the lowest level of waterlogged rotten rock.
4. *Bajadas or Piedmont Plains*: belts of ungraded medium or heavy-textured material at the bottom of the footslopes of Uplands and Terraces, usually formed of coalescent alluvial and colluvial fans of limestone or volcanic origin.
5. *Alluvial Plains*: fluvial deposits such as alluvial fans and former deltas, characterised by strata of well-graded material, and including heavy-textured backswamp clays.
6. *Lacustrine Plains*: areas where the original lake bottom of marl is exposed, and including former beaches and sandridges, sandplains of lacustrine origin and marshes.
7. *Marshes*: areas which are permanently waterlogged.
8. *Aeolian sandplain*: covered with shifting and fixed sand dunes.

These physiographic units may also be considered as soil landscapes or broad soil associations because each unit comprises soils which are geographically related. This division will therefore be the basis and the highest level of classification in the soil legend of the reconnaissance soil map. The soil association map, Fig. 7, shows the distribution of the units over the Basin. The topographic relation between the various units is illustrated in eight schematic sections across the Basin (Fig. 8). The soils of each association will be described in Chapter 4.

2.3 Climate

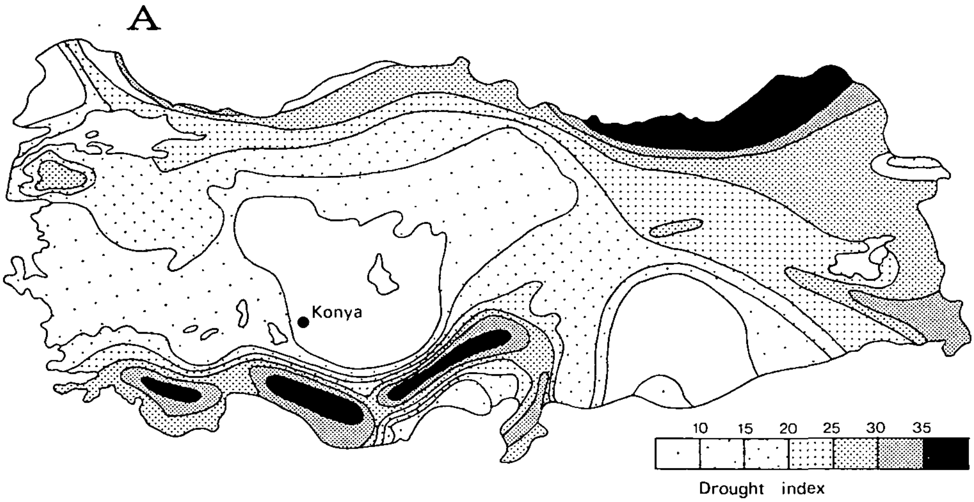
The Great Konya Basin is one of the driest parts of Turkey (Fig. 10). By the Köppen Classification the climate is semi-arid (BSak), with cold moist winters and hot dry summers. Evaporation exceeds total precipitation largely. The mountains in the south and west cause local variations especially in wind and precipitation. Recent climatic records from the Basin have been combined into diagrams to try to show the prevailing climate in particular factors which influence crop cultivation, irrigation and soil classification. Many records cover too few years to provide reliable averages. They are indicated. However, records have been carefully kept at Konya and Çumra for many years. Detailed information is given in DSİ climatological reports (Rasat Yılılığı, 1964) and in the reports of the State Meteorological Service. The most important data are reviewed in Table 1.

Temperature. Fig. 11 shows mean, maximum and minimum temperatures at some meteorological stations in the Basin. The number of frost days in each month or the length of frostfree period is also indicated. Frost can be severe as night temperatures of —25°C are common in winter. In summer, day temperature reaches 35°C. The range of temperature in 24 hours is high throughout the year. The average varies between about 0°C in winter and 22°C in summer. The Basin is covered with snow for at least 3 months in winter. This affects the temperatures but protects the soil from freezing as is indicated by the soil temperatures at Çumra (Fig. 12). The length of the frost-free period (about 165 days) governs the types of crops that can be grown in the Basin. The season is too short for rice, cotton and citrus fruits. Night frosts in spring make cultivation of apples and pears hazardous in most parts of the Basin, unless precautions are taken.

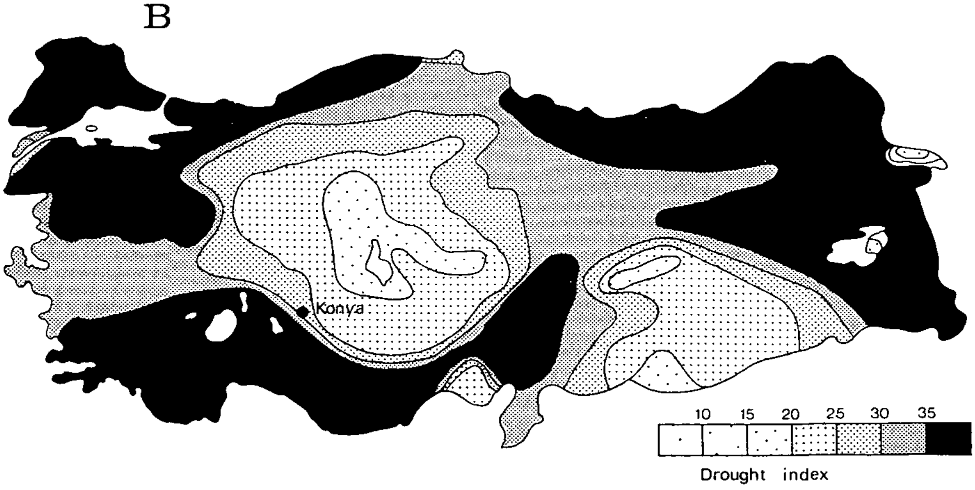
Precipitation. The distribution of annual precipitation in the Basin is shown in Fig. 13. Rainfall comes mostly as local showers, so that its distribution differs enormously from year to year. The yearly total decreases eastwards and towards the centre of the Basin. Fig. 14 A indicates variations in precipitation between years for Konya, Çumra and Karapınar. Total annual precipitation influences the amount of water that accumulates in the soil. Spring rain at the right time determines the growth of winter wheat but the heavy spring showers are unfortunately irregular in distribution and amount. Fig. 14B shows the May rainfall in different years at Konya, Çumra and Karapınar. Crop yields vary enormously over short distances because of this irregularity of spring rain.

Certain parts, like the one in the Karaman Area near Yağmurlar, which means rain, seem to have significantly more rainfall than elsewhere presumably because of topography but data from there were not available. Wintersnow thaws rapidly in March and releases large amounts of water which cause erosion and mud flows on the slopes and considerable flooding near the centre of the Basin.

Fig. 10. Drought Index map of Turkey in a dry (A) and in a wet year (B). After Birant (1960).

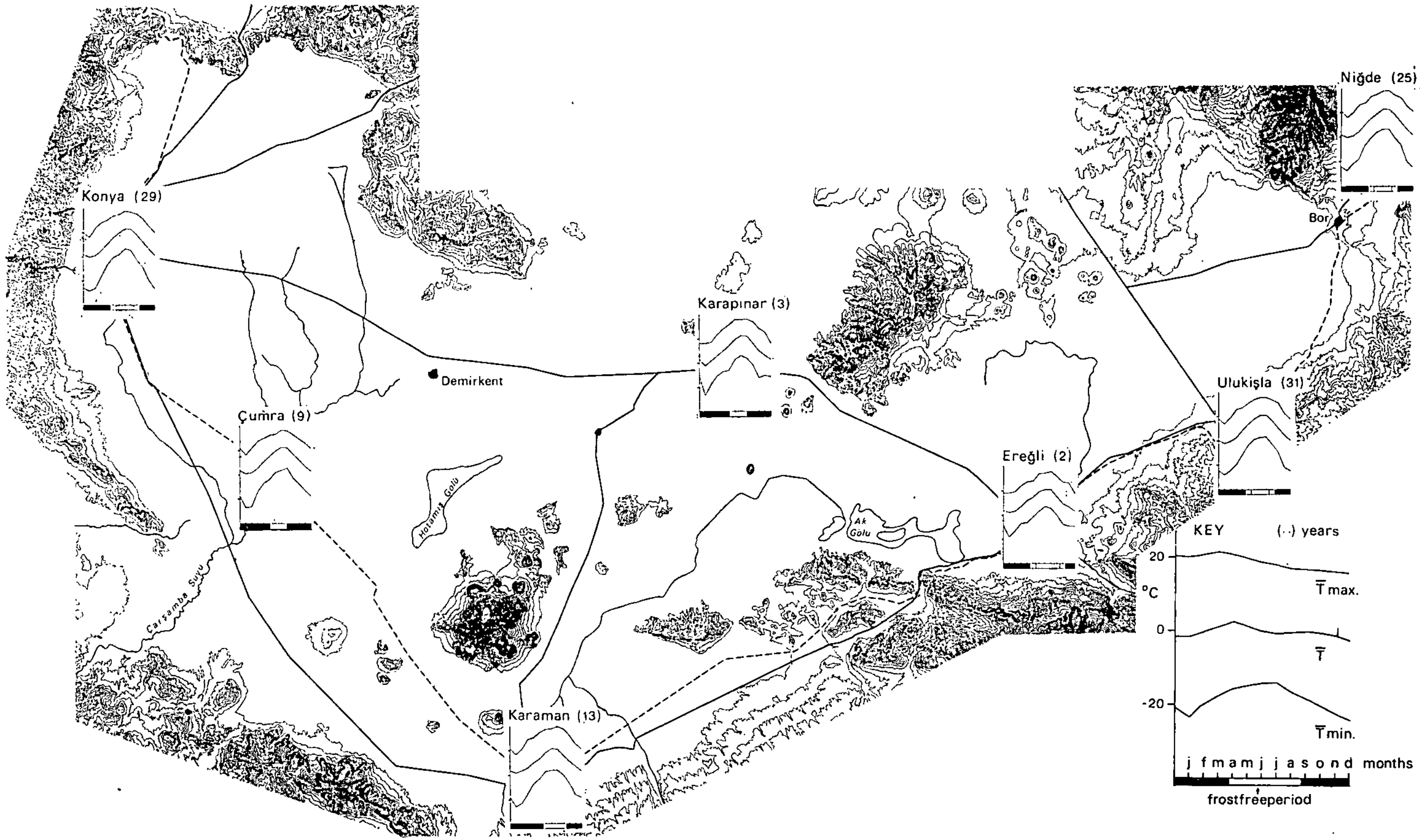


$$\text{Drought index} = \frac{\text{annual precipitation in mm}}{\text{mean ann. temp. in } ^{\circ}\text{C} + 10}$$



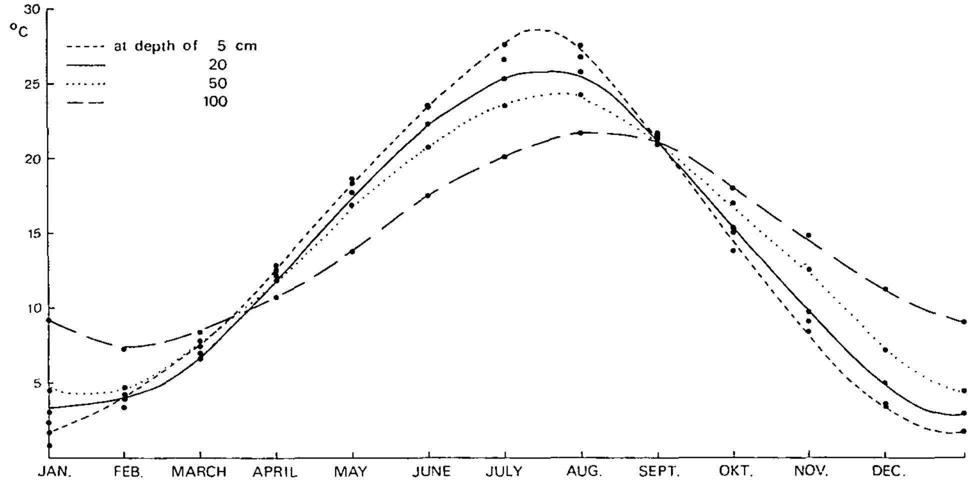
Şekil 10. Birant (1960)'a göre (A) kurak (B) yağışlı yıllarda Türkiye kuraklık indeksi haritası.

Fig. 11. Monthly averages of temperatures throughout the year and frostfree period at various places in the Great Konya Basin. From data of the State Meteorological Service, Ankara.



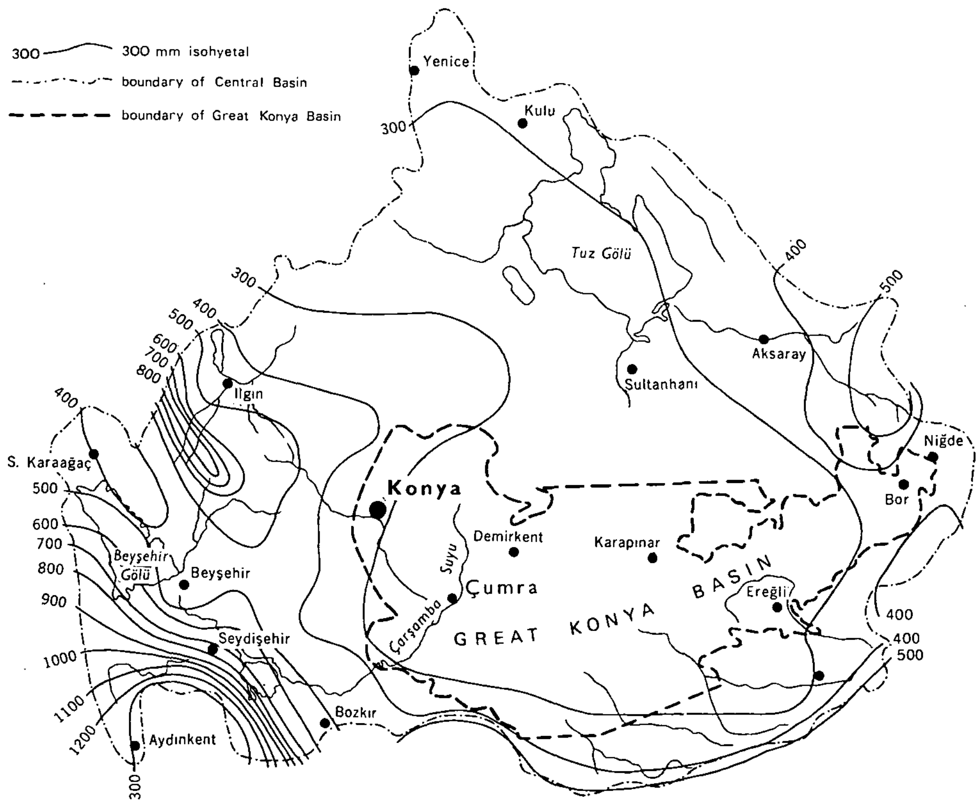
Şekil 11. Devlet Meteoroloji İşleri Genel Müdürlügü kayıtlarına göre Büyük Konya Havzasının çeşitli yerlerinde bütün yıl boyunca aylık sıcaklık ortalamaları.

Fig. 12. Average soil temperature at various depths in each month of the year (average over 9 years) at the Çumra Experimental Station.



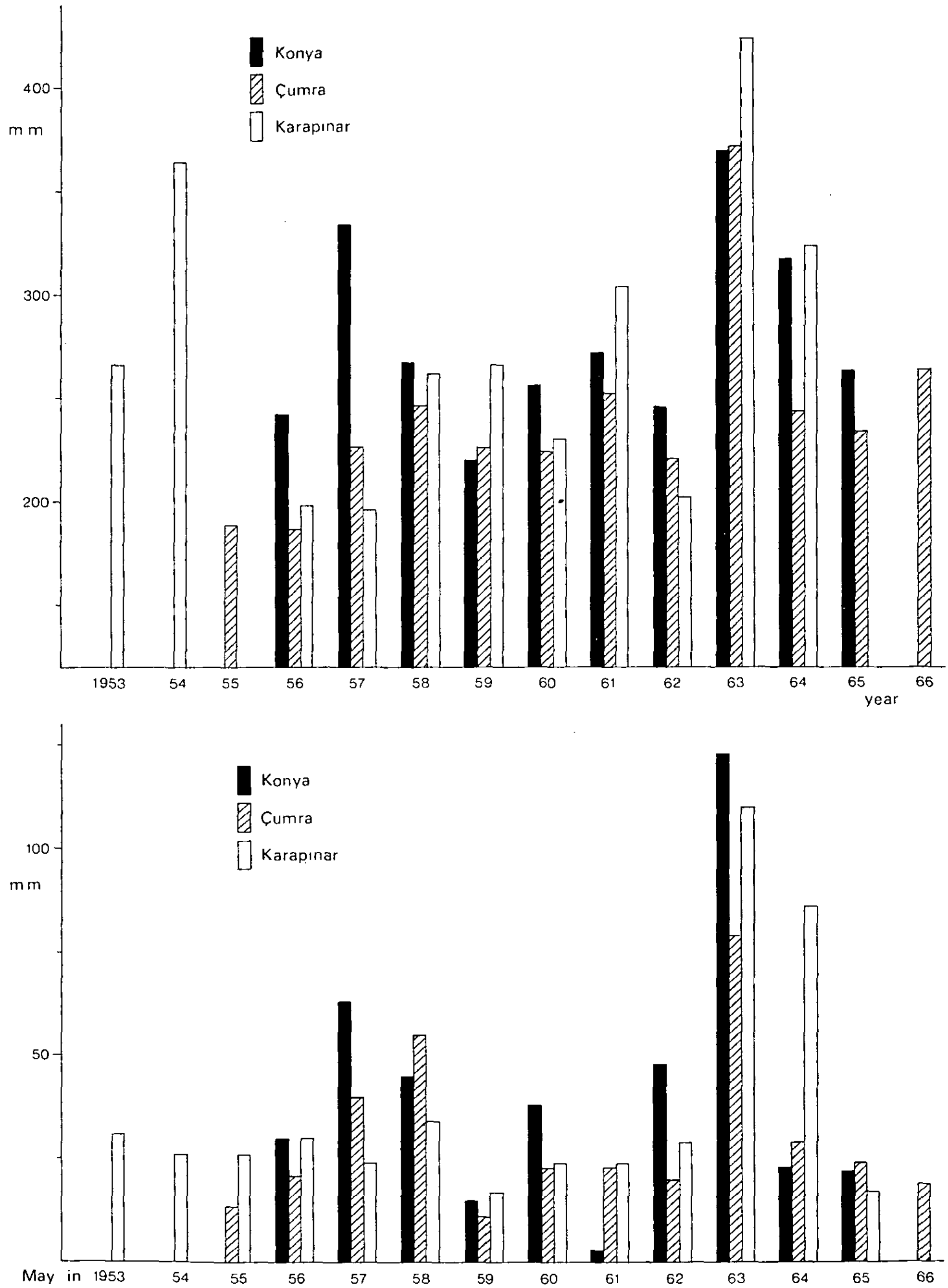
Şekil 12. Çumra Sulu Ziraat Deneme İstasyonunda yılın her ayı için çesitli derinliklende elde edilen ortalama toprak sıcaklığı (9 yıllık ortalamalara göre).

Fig. 13. Average annual precipitation in mm in and around the Great Konya Basin. From data of DSİ Ankara.



Şekil 13. Ankara D.S.İ. kayıtlarına göre mm olarak Büyük Konya Havzasında ve çevrelerinde senelik ortalama yağış.

Fig. 14. Above: Total annual precipitation in Konya, Çumra and Karapınar from 1955–1965.
Below: Precipitation in Konya, Çumra and Karapınar in the month May, from 1955–1965.



Şekil 14. A. 1955 yılından 1965 yılına kadar Konya, Çumra ve Karapınar'da tesbit edilen senelik yağış toplamı.

B. 1955 yılından 1965 yılına kadar Konya, Çumra ve Karapınar'da Mayıs ayı içinde tesbit edilen yağış.

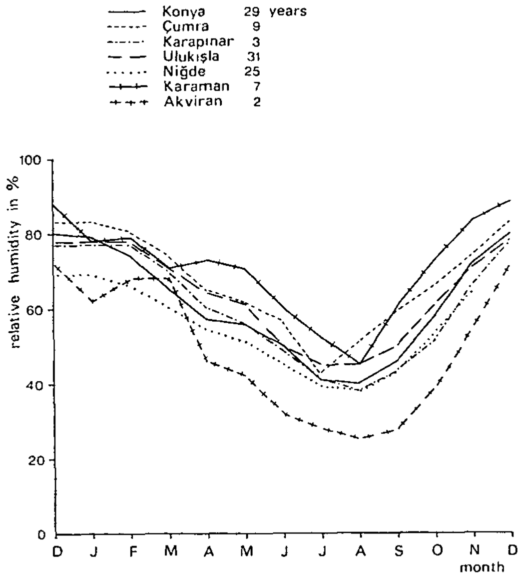


Fig. 15. Monthly average relative humidities at 7 places in the Great Konya Basin.

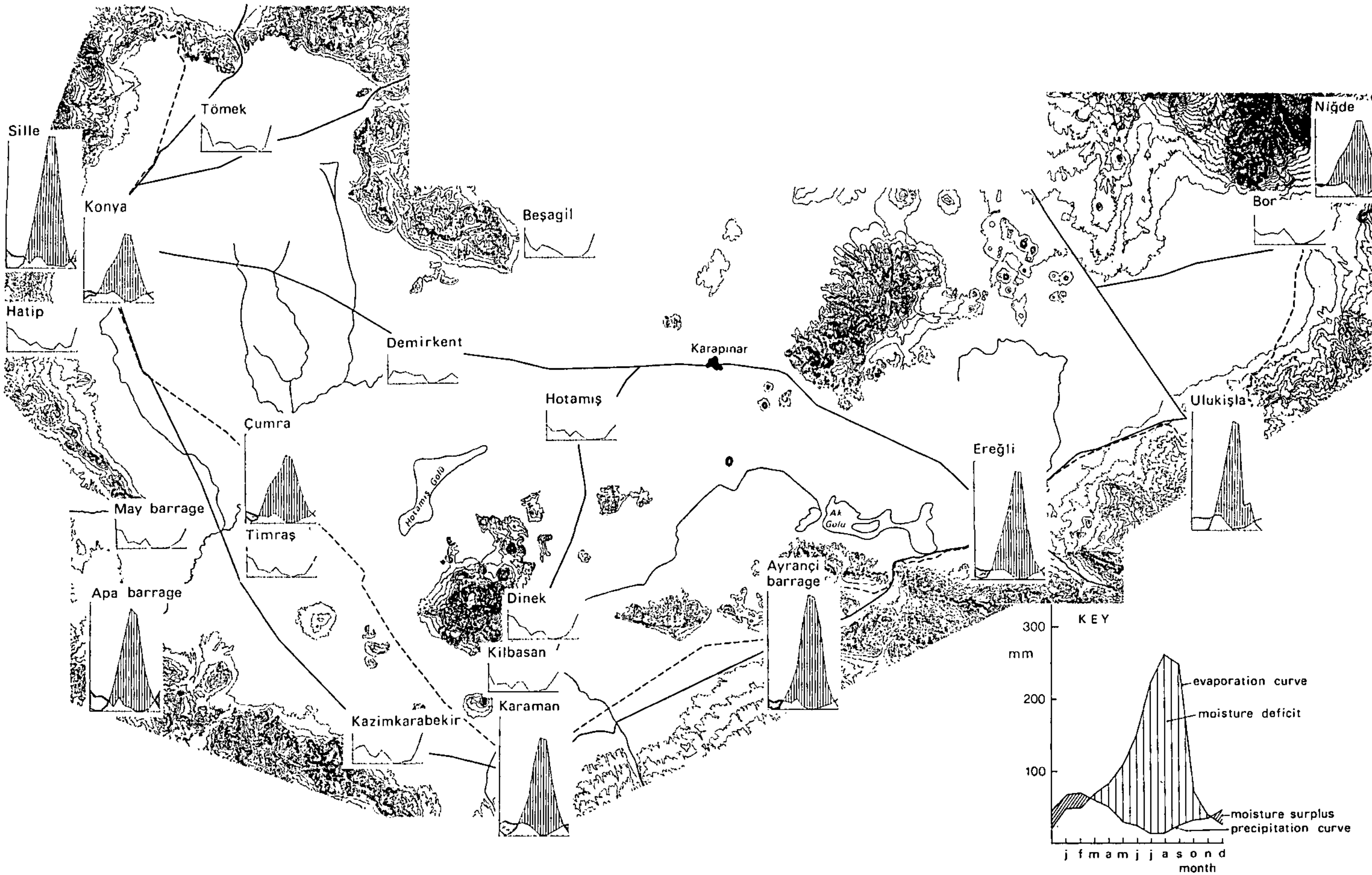
Şekil 15. Büyük Konya Havzasının 7 yerinde aylık ortalama nisbi nem.

Relative humidity. In summer relative humidity was about 40 or 50%, everywhere (Fig. 15). This and strong winds cause considerable drought damage, observed in crops. The data do not bring out the difference in relative humidity which could be sensed between irrigated areas (Konya, Çumra) and unirrigated ones (Karapınar).

Wind velocity and direction. In an open treeless area like the Great Konya Basin, wind is an important climatic factor. Northerly winds prevail in winter as witnessed by the orientation of the numerous sheep shelters (Turkish: Yayla) whose open side faces south. Southerly storms, however also occur mainly in spring and in summer and cause a steady move of the shifting sand dunes in the Karapınar Area northwards since wind erosion started (Groneman, 1967).

Evaporation. Yearly and seasonal evaporation is of the utmost importance in arid and semi-arid areas. From preciptation and evaporation can be calculated the available moisture for the crops and their supplementary water requirements if irrigation is possible. Evaporation from open water in a certain period depends on temperature, relative humidity and wind velocity. It can be calculated from the formula $E_0 = CT^2$ (E_0 is evaporation in mm/day, T average monthly temperature, C a constant varying between 0.5 and 1.0 to be determined empirically). Evaporation can be more accurately measured in special basins with an open water surface. Both methods have been used mainly by DSİ in estimating evaporation at various places in the Basin. However, measured values are higher than calculated values so that all values calculated by the official sources ought to be corrected by a factor of 0.85 for May and September and

Fig. 16 Average monthly precipitation, evaporation and moisture deficit at 10 places in the Great Konya Basin. From data of State Meteorological Service.



Şekil 16. Devlet Meteoroloji İşleri Genel Müdürlüğü kayıtlarına göre. Büyük Konya Havzasının 10 yerinde ortalama aylık yağış, buharlaşma ve su noksanlığı.

Table 1. Climatological data from several observation stations in the Great Konya Basin (Kindly provided by the State Meteorological Service in Ankara).

Station	Number of years	J	F	M	A	M	J	J	A	S	O	N	D	Year
Mean temperature in °C / Ortalama sıcaklık, °C olarak														
Konya	37	−0.2	1.4	5.0	11.0	15.9	19.8	23.2	23.1	18.0	12.4	6.7	1.9	11.5
Karapınar	2	−4.6	0.8	6.7	9.9	14.7	19.8	22.7	21.7	16.5	9.4	5.2	3.2	10.5
Karaman	6	1.2	2.4	6.0	10.7	14.0	19.8	22.9	22.4	17.1	12.2	8.0	4.7	11.8
Ereğli	2	2.3	3.4	7.1	12.5	14.8	19.5	21.4	21.2	15.2	9.5	7.3	3.7	11.4
Çumra	8	0.4	0.8	5.4	10.4	15.5	19.2	22.2	21.6	16.2	11.1	6.6	3.6	11.1
Extreme maximum temperatures in °C / En yüksek sıcaklıklar, °C olarak														
Konya	37	16.3	23.8	28.2	30.4	34.4	34.8	37.7	40.0	35.2	31.6	25.4	21.8	40.0
Karapınar	3	13.7	13.8	24.0	27.2	32.0	36.5	36.3	37.4	34.6	29.0	23.0	21.4	37.4
Karaman	6	17.2	21.1	25.0	27.0	33.1	37.5	38.1	38.7	37.9	32.6	25.8	21.3	38.7
Ereğli	2	18.0	19.4	24.3	27.5	28.2	34.2	34.6	36.0	31.8	27.3	26.6	18.0	36.0
Çumra	8	16.5	22.0	27.5	27.0	32.5	35.0	37.0	36.5	33.0	29.2	26.0	21.5	37.0
Extreme minimum temperatures in °C / En düşük sıcaklıklar, °C olarak														
Konya	37	−28.2	−26.2	−16.4	−6.6	−0.7	1.8	6.7	5.3	−3.0	−8.4	−19.0	−26.0	−28.2
Karapınar	3	−25.6	−17.2	−10.3	−6.4	−5.6	6.0	6.4	5.0	−1.6	−12.1	−10.1	−15.0	−25.6
Karaman	6	−26.8	−16.0	−10.8	−7.0	−3.1	3.1	6.6	5.9	0.2	−6.7	−10.5	−13.8	−26.8
Ereğli	2	−18.1	−13.0	−6.8	−6.3	−1.4	3.4	7.4	5.8	0.2	−7.5	−9.0	−8.9	−18.1
Çumra	8	−26.8	−23.0	−14.0	−7.0	−3.8	2.0	4.0	4.5	−0.5	−9.0	−11.0	−13.0	−26.8
Mean number of days with minimum temperatures below 0°C / Minimum sıcaklığı 0°C nin altında olan günlerin ortalama sayısı (donlu günler).														
Konya	37	25.1	21.2	17.0	4.3	0.1	–	–	–	0.1	2.8	11.8	20.9	103.3
Karapınar	2	26.0	23.0	13.0	9.0	1.0	–	–	–	1.0	20.5	21.0	18.0	132.5
Karaman	6	20.5	17.5	13.5	4.8	0.2	–	–	–	–	4.5	12.0	13.8	86.8
Ereğli	2	17.0	19.5	11.0	3.0	1.0	–	–	–	–	7.5	10.0	16.5	85.5
Çumra	8	20.0	20.4	15.6	5.0	0.4	–	–	–	0.2	6.2	13.5	16.3	97.6
Mean relative humidity in percentages / Ortalama nisbi nem, yüzde olarak														
Konya	36	78	74	64	57	56	50	41	39	46	58	71	80	60
Karapınar	2	78	80	73	61	59	53	44	40	41	51	66	77	60

Çumra	8	83	82	75	67	63	59	50	52	60	68	75	83	68

Mean number of clear days / Ortalama açık gün sayısı

Konya	37	2.6	2.7	4.0	4.3	4.5	11.3	20.0	21.6	18.6	11.0	5.5	2.9	108.9
Karapınar	2	8.5	2.0	1.5	5.0	2.5	8.0	24.5	27.0	22.0	17.5	6.0	2.0	126.5
Karaman	7	3.1	1.9	4.9	3.9	6.4	13.0	21.6	26.1	20.0	12.8	6.7	3.6	124.0
Ereğli	2	2.0	0.5	3.0	1.5	5.5	11.0	22.0	22.0	15.5	9.0	4.5	1.5	98.0
Çumra	8	3.6	2.3	3.0	3.1	6.1	10.4	18.8	24.8	19.9	12.6	7.1	3.1	114.9

Mean precipitation in mm / Ortalama yağış, mm olarak

Konya	37	37.3	33.1	30.6	28.8	43.0	26.4	5.6	3.1	11.6	26.7	29.4	39.6	315.1
Karapınar	12	36.8	33.8	28.3	24.0	38.4	21.0	2.7	0.7	5.8	14.5	22.3	44.8	273.2
Karaman	36	44.5	42.4	35.0	38.9	36.5	23.6	3.8	2.5	9.6	25.4	34.0	45.9	342.1
Ereğli	17	31.0	33.2	32.1	34.4	36.3	23.6	2.5	1.7	5.9	20.0	23.9	38.1	282.7
Çumra	9	25.7	28.3	23.0	20.6	33.6	23.4	0.7	0.5	8.3	22.3	19.9	42.9	249.3
Bor	8	31.1	38.4	39.9	38.2	56.3	34.1	5.4	0.2	8.2	12.5	30.6	43.5	338.4
Kılbasan	2	14.2	35.5	28.9	15.5	36.2	51.8	0.2	—	0.3	14.0	30.7	79.6	306.8
Sille	2	19.6	47.9	47.2	17.3	40.5	50.9	6.2	1.6	1.4	9.9	30.5	65.5	338.5
Hotamış	2	17.4	42.2	38.7	7.5	30.2	19.3	0.2	1.6	0.6	8.3	31.9	54.2	251.9

Daily greatest amount of precipitation in mm / Günlük en yüksek yağış miktarı

Konya	37	27.8	73.7	33.2	27.3	33.0	49.1	17.4	18.1	30.2	56.6	61.9	41.7	73.7
Karapınar	13	32.4	33.0	21.4	29.5	27.5	25.1	17.0	4.4	14.9	28.0	25.6	20.6	33.0
Karaman	35	37.2	35.5	33.3	54.9	69.8	42.6	28.8	13.7	26.2	32.5	49.7	41.0	69.8
Ereğli	16	22.7	21.4	19.1	20.9	37.1	33.5	9.1	12.8	15.3	28.5	34.6	27.8	37.1
Çumra	9	16.4	19.6	15.6	13.3	27.5	21.6	2.8	3.4	14.2	33.3	21.2	17.8	33.3
Bor	8	28.4	23.0	39.2	27.9	26.7	33.0	31.9	1.0	16.3	17.9	25.5	22.3	39.2
Kılbasan	2	10.0	11.7	20.3	6.8	12.2	32.8	0.3	0.0	0.6	13.0	20.5	40.0	40.0
Sille	2	13.2	17.1	20.5	8.4	12.5	15.8	5.9	2.3	1.3	6.6	33.2	21.5	33.2
Hotamış	3	9.2	12.8	16.7	5.2	14.5	18.6	2.3	3.1	3.5	4.9	21.4	16.5	21.4

Continued on following pages.

Table 1. Continued.

Station	Number of observations	Months of the year												Year
		J	F	M	A	M	J	J	A	S	O	N	D	
Mean number of days with precipitation of 0.1 mm or more / Yağışı 0, 1 veya daha fazla olan günlerin ortalama sayısı														
Konya	37	9.9	8.4	8.9	8.3	9.9	6.4	1.9	1.1	2.8	5.6	6.3	10.4	79.8
Karapınar	12	7.0	7.6	7.0	6.0	7.8	4.0	0.6	0.2	1.6	2.9	4.5	8.5	57.8
Karaman	34	8.1	7.5	8.0	7.4	6.9	4.4	1.1	0.5	2.0	4.7	5.8	8.7	65.2
Ereğli	16	8.1	7.7	9.1	8.2	7.7	4.4	0.6	0.4	1.8	4.8	4.9	8.4	66.4
Çumra	8	9.0	8.6	8.2	6.9	7.8	5.8	0.6	0.5	2.1	5.0	5.0	9.4	69.0
Bor	8	6.2	8.5	8.9	7.6	9.5	5.2	0.7	0.4	2.1	3.3	5.3	8.9	66.8
Kılbasan	2	6.5	10.0	9.5	8.0	9.5	7.5	0.5	–	0.5	4.0	4.0	13.0	73.0
Sille	2	7.0	9.5	9.5	6.5	10.0	10.0	3.0	1.0	1.0	2.0	4.0	10.5	74.0
Hotamış	2	7.0	10.5	9.5	5.5	7.5	6.0	0.5	0.5	0.5	3.0	4.5	12.0	67.0
Mean number of days with snow on the ground / Karlı günlerin ortalama sayısı														
Konya	37	7.9	5.9	2.3	0.2	–	–	–	–	–	–	0.6	3.9	20.8
Karapınar	11	4.4	4.0	1.2	0.1	–	–	–	–	–	–	1.1	2.3	13.1
Karaman	32	7.0	6.0	2.1	0.4	–	–	–	–	–	–	0.5	4.2	20.2
Ereğli	15	7.1	4.9	1.9	0.1	–	–	–	–	–	–	1.6	4.0	19.6
Çumra	8	3.0	4.0	1.0	–	–	–	–	–	–	–	0.6	0.5	9.1
Bor	6	7.8	7.5	0.7	1.0	–	–	–	–	–	–	0.2	1.8	19.0
Kılbasan	2	4.5	4.0	0.5	0.5	–	–	–	–	–	–	0.5	2.5	12.5
Sille	2	5.5	11.0	–	–	–	–	–	–	–	–	–	3.0	19.5
Hotamış	2	9.5	7.5	1.5	0.5	–	–	–	–	–	–	0.5	1.5	21.0
Extreme maximum of snow depth in cm / En yüksek kar derinliği, cm olarak														
Konya	35	48	66	37	13	–	–	–	–	–	–	17	25	66
Karapınar	11	32	15	8	2	–	–	–	–	–	–	22	14	32
Karaman	29	66	27	24	8	–	–	–	–	–	–	5	20	66
Ereğli	15	20	22	28	4	–	–	–	–	–	–	20	30	30
Çumra	8	10	14	3	–	–	–	–	–	–	–	5	8	14
Bor	2	13	14	2	5	–	–	–	–	–	–	2	4	14
Kılbasan	2	8	7	1	2	–	–	–	–	–	–	4	5	8
Sille	2	6	15	–	–	–	–	–	–	–	–	–	14	15

Konya	17	3.0	3.2	3.6	3.6	3.2	3.3	3.8	3.5	3.2	2.7	2.5	2.6	3.2
Karapınar	2	2.7	4.3	3.5	4.3	2.9	3.3	4.1	3.9	3.6	2.9	3.6	3.9	3.6
Karaman	2	2.9	2.8	2.9	3.1	2.2	1.8	2.1	1.9	1.3	1.4	2.2	3.2	2.4
Çumra	2	2.5	3.5	3.1	5.0	3.5	2.8	3.1	2.8	2.3	2.2	2.5	2.7	3.0

Extreme maximum wind speed (m/sec) and directions / En yüksek rüzgâr hızı (m/saniye olarak) ve yönü

Konya	17	S	SSE	SW	SSW	NNW	NW	SW, NW	NNW	WSW	SW	SW	SSE	SW
		25.8	23.1	23.6	27.2	20.3	20.6	20.6	23.2	22.3	24.6	29.1	20.1	29.1
Karapınar	2	SSW	SW	SSW	SSW	SSW	ENE	NNE	NNE	S	NW	SSW	SSE	S
		27.3	29.0	32.5	32.7	22.7	23.0	20.1	18.2	32.8	19.6	21.8	22.7	32.8
Karaman	2	SW	S	S	SW	S	SSW	SE	S	S	W	W	SSE	SW
		19.2	18.3	18.2	17.3	11.7	12.0	6.9	8.6	15.2	14.7	15.3	15.0	19.2
Çumra	2	S	S	SE	S	S	SSE	NW	N	S	S	SE	S	S
		14.7	18.7	15.5	25.8	16.0	8.6	9.6	10.1	17.8	12.5	15.4	20.0	25.8

Mean number of days with gale / Ortalama fırtınalı gün sayısı

Konya	17	0.5	0.5	0.9	0.8	0.6	0.3	0.2	0.4	0.2	0.1	0.3	0.2	5.1
Karapınar	2	1.5	6.5	3.5	8.0	3.0	6.5	2.5	1.0	3.0	2.5	3.5	3.5	45.0
Karaman	6	1.3	0.3	0.3	0.3	—	—	—	—	0.2	—	—	0.8	3.3
Çumra	6	—	0.9	0.5	1.2	0.2	0.3	0.2	0.3	0.2	0.2	—	0.8	4.7

Mean sunshine duration in hours per day / Ortalama güneşlenme süresi, günün 24 satında saat olarak

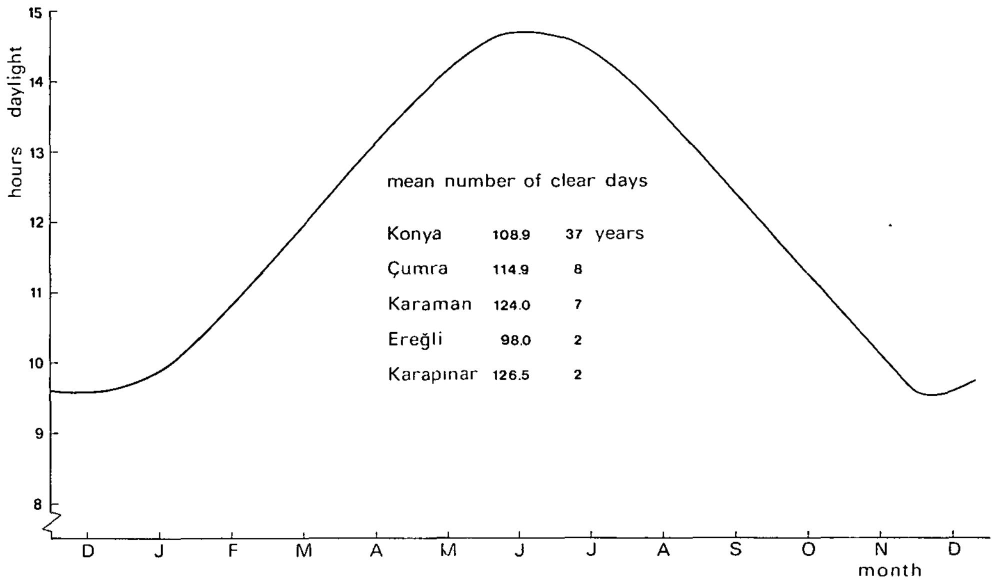
Konya	16	3.6	4.7	5.6	7.5	9.4	11.2	12.4	12.1	9.8	7.5	5.9	3.5	7.8

Tablo 1. Büyük Konya Havzasının çeşitli yerlerinde iklim kayıtları (Ankara Devlet Meteoroloji İşleri Genel Müdürlüğünün Lütfuyla temin edilmiştir).

0.65 for June, July and August to obtain more realistic figures. Fig. 16 shows all available data, corrected where necessary, for precipitation, evaporation and net moisture balance at various places in the Basin. Evaporation is greater than rainfall over most of the year.

Daylength. Fig. 17 is the daylength diagram for 37° north. The shortest day of about $9\frac{1}{2}$ hours is in December, the longest is almost 15 hours, in June. Daylength is of importance for certain daylength-sensitive crops.

Fig. 17. Daylength curve (hours of daylight) over one year and table of average numbers of clear days per year at 5 places in the Basin.



Şekil 17. Havzanın 5 yerinde bir yıl boyunca gün uzunluğu eğrileri (güneşlenme saatleri) ve 1 yıl için ortalama açık günlerin sayısı.

2.4 Natural vegetation

The Basin is entirely treeless, except for narrow strips along rivercourses and irrigation canals, some poplar plantations in irrigated areas and the carefully tended shade trees along main roads.

The natural vegetation cover can broadly be divided in four categories:

1. The species-rich vegetation of herbs and grasses in cultivated or protected areas with saltfree soils of the Terraces, Bajadas Colluvial Slopes and Alluvial Fans.

2. Herbs and grasses in ranged areas or slightly (internally) salt-affected soils of the

above main land units and the Marl Plains. Dominant species are *Artemisia fragrans*, *Noaea mucronata*, *Alhagi camelorum* and *Peganum harmala*.

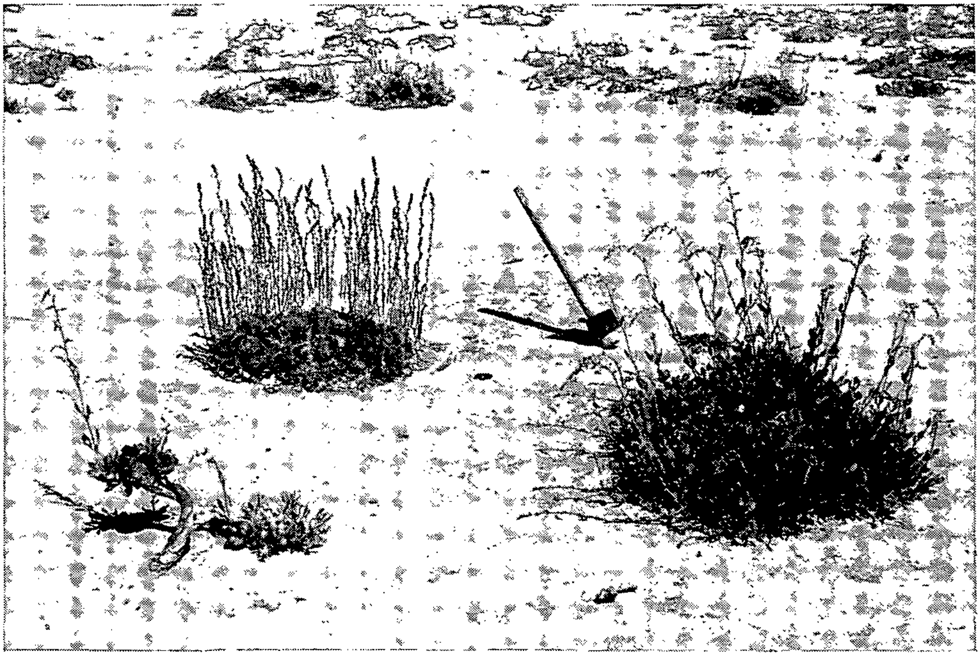
3. Halophytes in the moderately and strongly (externally) salt-affected soils of the Alluvial Fans and Marl Plains. Dominant species are mainly Chenopodiaceae, like species of *Halocnemum*, *Salicornea*, *Sueda*, *Petrosimonia*, *Salsola*, *Halimione* and *Camphorosma*.

4. Reeds and rushes in the slightly salt-affected marshy areas. Dominant are *Juncus acutus*, *J. maritimus* and *Typha* spp.

The natural vegetation outside the irrigated areas is of hardly any economic importance. The uncultivated plains are overgrazed and support degraded steppe vegetation. The playas (salt pans) have little or no vegetation (Fig. 18). The marshes, if not too saline, seem to have some scope for development into range after introduction of better grasses (Ziba, 1967). Reeds for roofing are harvested in the marshes bordering Hotamış Gölü.

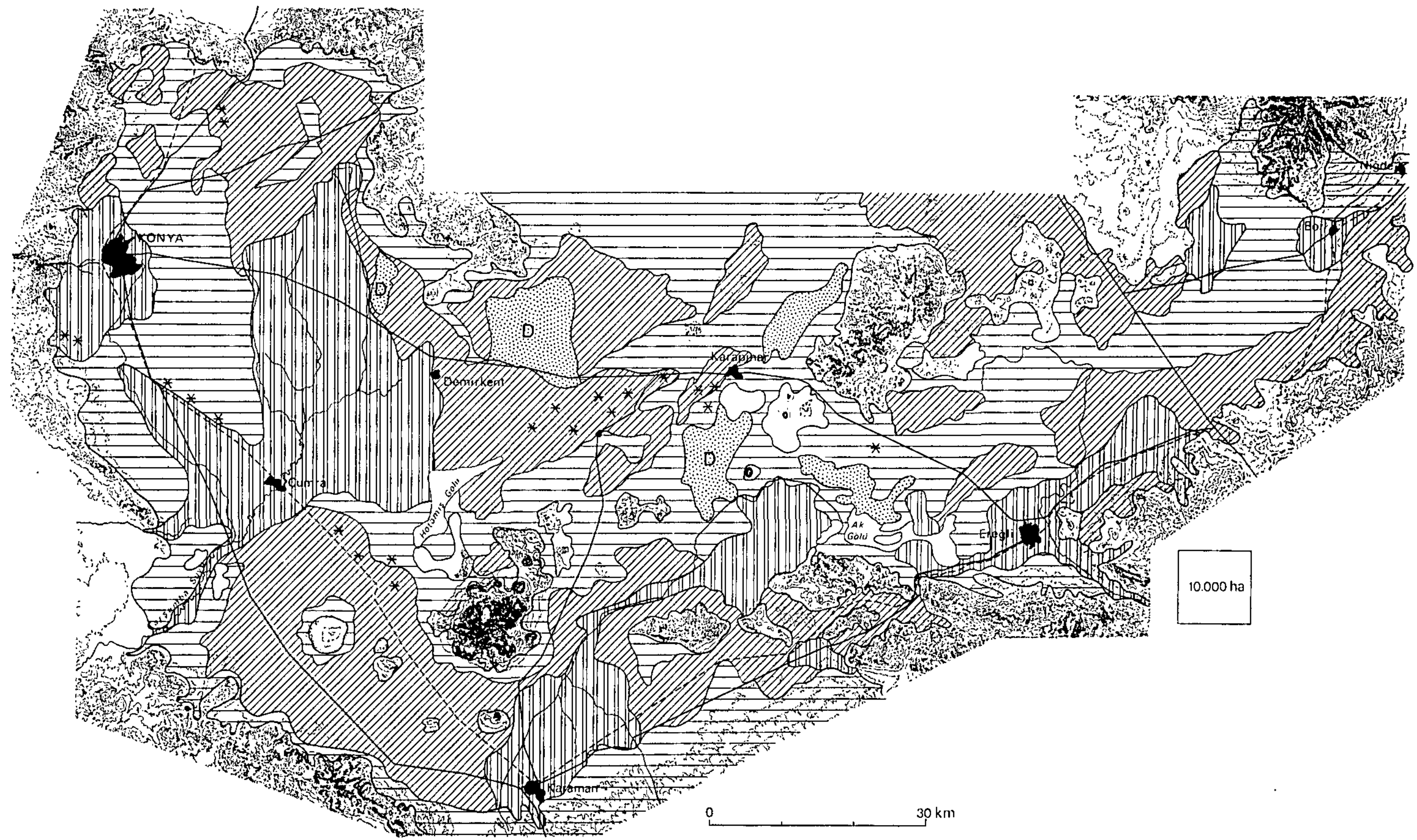
There are only a few indications of correlation between type of soil and vegetation. Differences are almost entirely governed by land-use, soil moisture, watertable and salinity, but there are clear links between degree and type of salinity and certain species. For further details see de Wit (1970).

Fig. 18. Halophytic vegetation in strongly salt-affected soil (LmD) near Ak Göl, Karapınar Area. Species: in the middle *Camphorosma monspeliaca* (L), lower left and right *Halimione portulacoides* (L) Aellen.



Şekil 18. Karapınar bölgesi Akgöl yakınlarında fazlaca tuz etkisinde kalmış toprakta (LmD) halofatik bitkiler. Türler: Ortada *Camphorosma monspeliaca* (L), daha aşağı sağ ve solda *Halimione portulacoides* (L) Aellen.

Fig. 19. Landuse in the Great Konya Basin. Approximate situation in 1965.



Şekil 19. Büyük Konya Havzası'nda 1965 yılında yaklaşık olarak arazi kullanma durumu.

3 Agricultural and economic geography

The actual land use of the Basin is shown in Fig. 19. Apart from the wastelands (dunes and playas or salt pans), there are rangelands (Turkish: mera), dry arable (Turkish: tarla) and irrigated arable.

3.1 Farming

Dry-farming. The large tracts of range are grazed communally and owned by the Turkish government. The area supports sheep, goats, cattle and horses. Nomadic Türkmen, as near Karapınar, keep camels and harvest the camelthorn (*Alhagi camelorum*) as fodder (Fig. 20). It is interspersed with dry arable and since World War II mera has been increasingly converted to tarla. As throughout Central Anatolia, the main crop is winter wheat. There is some barley and oats on poorer soils. Wheat germinates irregulary, 10 to 63 days after sowing (Watermanagement, 1965), according to when the rains start. If little snow covers the ground, the cold may kill late germinating seedlings, so that resowing may be necessary. During May and June, demands for moisture are again high during stem elongation and ear formation.

Yields depend much on the soil. Since World War II rangeland has increasingly come under cultivation, legally or illegally, with tractors and ploughs subsidized by American Aid. This indiscriminate ploughing has sometimes caused soil deterioration. Salt-affected lands have produced poor arable which would be better under steppe vegetation. After the harvest, the land is kept under stubble and ploughed the next spring. This fallow practice is to conserve moisture and restore fertility (see also B. H. Janssen in part B). The ploughing in spring breaks upward capillary flow and reduces losses of moisture by evaporation. The ground is again harrowed in October before sowing. Hardly any fertilizer is used.

Fig. 19. Legend.

Uplands/Yüksek araziler

Irrigated arable/Sulu ziraat

Dry arable/Kuru ziraat

Dry range/Kuru mera

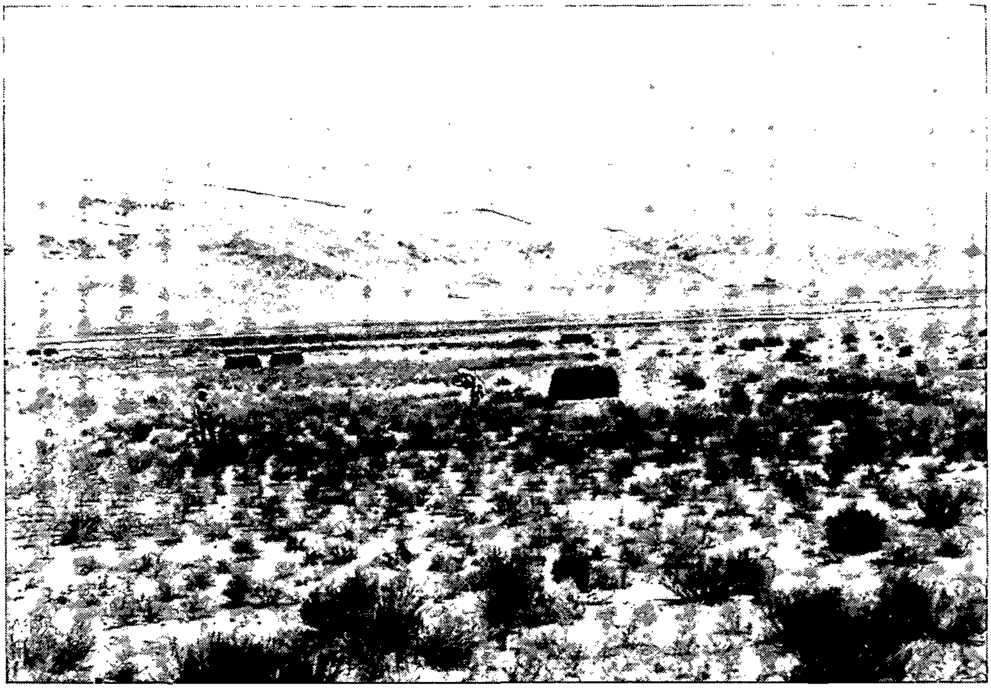
Wasteland (dunes or playas)/İşlenmeyen arazi (kumlar ve playalar)

* Local irrigation from deep wells/Derin kuyulardan mevzii sulama

D Sand dunes/Kum kümesi

Şekil 19. Lejant.

Fig. 20. Nomads harvesting camelthorn (*Alhagi camelorum*) east of Krater Göl, Karapınar Area. In foreground Volcanic Bajada Soils (BvB), in background Volcanic Uplands (UvA).



Şekil 19. Karapınar bölgesinde Krater Göl'ün doğusunda deve dikeni (*Alhagi camelorum*) biçen göçebeler. Ön plânda volkanik bajada toprakları (BvB), arka plânda volkanik yüksek araziler (UvA).

Irrigated arable farming. Even with irrigation many subtropical crops such as cotton, tobacco and citrus, fail because of the short frostfree season, poor drainage and consequent salinity, and poor soil (Chapter 8). As in dry areas wheat is the main crop. The practice of fallowing has been retained, presumably to restore fertility in the absence of manure and fertilizers. Cereals are irrigated once in early spring. Sugar-beet, melons, alfalfa, sunflowers and fruit-trees require irrigation also in summer.

In the Çumra Irrigation Area (25 000 ha) cropping is cereals 70, sugarbeet and fruit-trees each 10, and melons and lucerne each 5% (Watermanagement, 1965). Sugar-beet is grown on contract for a factory at Konya, which ensures supplies of fertilizer and gives advice for proper use. Lucerne (as a fodder), melons and sugar-beet are often grown in rotation.

3.2 Agricultural production

Only rough figures can be estimated for the whole Basin. Data from the Cooperative Grain Silos of the State Harvest Bureaus (TMO) in Konya, Karapınar, Ereğli, Karaman and Çumra and from the sugar factory in Konya include material from outside the Basin. For statistical purposes it is included in the South-Central Region, one of the nine agricultural regions of Turkey, and in Konya Province (Table 2). The Province produces about 16% of the nation's cereals and produces an important amount of chickpeas, sugar, melons, grapes and livestock (Preliminary, 1967). Between 1945 and 1960 total production in the province doubled as new rangeland came under cultivation. Further increase must relay on intensification of existing arable by irrigation and use of fertilizer (Chapters 7 and 9).

Table 2. Cropped area and livestock production of South-Central Region and Konya Province as a percentage of national total (from Preliminary, 1967)

Crops	Area sown		Production	
	Region	Konya	Region	Konya
Wheat	23.0	13.6	25.8	16.8
Barley	21.6	12.4	27.0	18.1
Rye	48.4	11.5	53.2	14.1
Oats	21.7	20.3	29.3	28.0
All cereals	*22.4*	*12.4*	*25.3*	*15.9*
Chick peas	20.1	7.5	22.8	9.7
Potatoes	22.1	5.7	27.4	6.9
Sugar-beet	20.0	9.1	20.0	9.6
Onions	15.0	4.0	19.8	5.9
Melons	16.7	6.1	16.4	8.6
Grapes	21.8	9.8	17.9	7.0
Non-citrus fruits	16.5	4.4	14.0	3.7

Livestock and livestock products	Number		Production	
	Region	Konya	Region	Konya
Sheep	18.1	7.8	14.6	6.5
Goats	7.4	3.8	5.8	2.9
Angora goats	23.6	12.1	39.9	23.9
Cattle	7.8	2.6	—	—
Horses	17.7	9.7	—	—
Wool			20.0	9.1
Mohair			17.8	9.2

Tablo 2. Güney Merkezi Bölgesinin ve Konya ilinin milli toplamın yüzdesi olarak mahsul sahası ve hayvani mahsulleri (1967 yılındaki ilk çalışmalardan).

Considering the soils and the amount of irrigation, yields per hectare in one year in the sown areas are probably above the national averages, which are for the period 1956–1965 wheat 1070 kg/ha, barley 1250 kg/ha, rye 1050 kg/ha, oats 1200 kg/ha, potatoes 10477 kg/ha, and sugar-beet 20660 kg/ha (Summary, 1966).

3.3 Existing and planned irrigation

The shape of the Basin and the high rainfall in the uplands, especially to the west and south, favour irrigation. Many rivers enter the Basin and some flow throughout the year. But a problem is the lack of outlet and even internal drainage is poor for the leaching of salts accumulating in low-lying areas. At the foot of the alluvial fans are marshes which flood, especially after the winter. East of Konya, north-east of Karaman and near Ereğli, the marshes have been drained through long channels, mainly to combat malaria.

Most of the old systems on or near alluvial deposits of the big rivers are primitive: near Konya from the River Meram, near Çumra from the river Çarşamba, near Karaman from the rivers Çamurluk, Deli and Selereki, near Ayrancı and Serpec from the River Ayran, near Ereğli from the River Zanopa, east of Ereğli from the River Çakmak, and near Bor and Niğde from the River Bor. Those near Konya, Çumra and Ereğli are being modernized.

Longer irrigation canals supply such areas as between İçeriçumra and Konya.

Other areas use deep wells as near Hatip south-west of Konya, Kaşınhanı and Arikören in the Çumra Area, Saslıpınar in the Hotamış Area, and Yenizengen in the north of Ereğli Area. (See fig. 19).

The first modern irrigation project near Çumra, completed in 1912 under the auspices of the Ottoman Anatolian Railway Co., was contracted out to Holzman GMBH of Frankfurt-on-Main, and was designed and supervised by the Dutch engineers Waldorp and Waldorp. Dams were built on the River Çarşamba and on Beyşehir Gölü. The shallow Suğla Göl was bypassed to avoid evaporation losses, and many canals, sluices and diversions were constructed to regulate the water in the plain (Hoeffelman, 1913). The Ottoman Government even brought in better farmers from the Balkans (Frey, 1925).

The first decade more than fulfilled hopes and the scheme received publicity all over the world (Correspondent, 1907; Woods 1910). But gradually yields decreased as the canals deteriorated and as soils became salt-affected through lack of flushing and uncontrolled water supply.

In 1962 the Apa Dam was built a few miles upstreams from the first diversion canal. Since then heavy waterlosses during floods have been prevented. From 1962 to 1964 several drainage specialists from the International Institute for Land Reclamation and Improvement (IILC) of Wageningen, the Netherlands, appointed by FAO, studied the problems and made their recommendations (Watermanagement, 1965). The design is being extensively improved and canals are being lined by DSİ (Devlet Su İşleri) and Topraksu, both Turkish Government agencies.

In 1967, the Turkish Government appointed an American consulting agency, the International Engineering Co, to make an entirely new plan to extend irrigation over a much larger part of the Great Konya Basin with both surface and ground water. New structures are proposed near Beyşehir Gölü to prevent the enormous losses to lower strata in the limestone. The plan also suggests drainage canals to the Karapınar Area and from there to a tunnel to the deeper Tuz Gölü depression north of the Great Konya Basin (Preliminary, 1967).

3.4 Population and communication

Towns. The ancient town of Konya is capital of the large Province of Konya and most important city in Central Anatolia. Its population in 1965 was about 158 000 and had increased by 6.3% since 1960. It is the industrial and agricultural centre of the region. Konya was presumably founded about 1200 B.C. by the Phrygians. The Romans called it Iconium. For over 900 years it was the capital of the Seljuk Sultans of Asia Minor. The town contains much of great historic interest. Other towns of regional importance are Karaman (20 000 inhabitants), Karapınar (8000), Ereğli (3000), Bor (14 000) and Çumra (10 000). Çumra started to grow as a station on the Baghdad railway line which connects Istanbul with Adana, via Konya, Karaman, Ereğli and Bor. In 1912 Çumra became administrative centre of the Çumra Irrigation Project and since 1950 has had the important Experimental Station for Irrigated Agriculture (Bölge Sulu Ziraat Deneme İstasyonu), under the Ministry of Agriculture. All the towns are connected by good all-weather roads, partly asphalted or in an advanced stage of construction (Fig. 1).

Rural areas. Outside the towns, the Basin is utterly rural. Villages and yaylas (summer settlements) are scattered evenly over the plains and border areas. Most are marked on the topographic base of the soil map. Hardly any villages and yaylas have modern conveniences such as piped water and electricity, but schools and medical facilities are adequate and improving. Literacy, about 50%, is near the national average of 48%. Petrol stations are sprouting all over the Basin. The villages are connected by dust-roads which are readily passable in summer but difficult in winter. Transport of goods and persons in the rural areas is mainly by regular buses, jeep-taxis, tractors and horsecarts.

4 The soils. Use of the maps and unit descriptions

4.1 General characteristics

Parent material The soils of the Great Konya Basin are all developed in clastic sediments, brought in from the Uplands. The soil formation depended mainly on the texture and lime content of this sedimentary parent material, and also on climate and topography. The Terraces, Colluvial Slopes, Alluvial Plains and Bajadas are all loamy or clayey and have a lime content of 10–25 %. The Lacustrine Plains with exception of the sandy Ridge Soils (Lr) and the Sandplains and Beach Soils (Lp) are clayey and all have a carbonate content of 40–60 %. The Soft Lime Soils (Tc) and the Marsh Soils (Mf) consist of almost pure Ca/Mg carbonates and sometimes gypsum. Volcanism in the Basin catchment area has provided enough heavy minerals to produce smectite-type clay minerals in all soils.

Topography The borders of the Basin are much better drained than its centre, which is lower. In these low-lying parts are expanses of saline soils or even playas (salt pans; see Chapter 6).

Arid climate has mainly influenced structure and caused weak A horizons and pronounced B and C horizons often with a clear calcic horizon at about 50 cm in the less recent soils in the Terraces and Bajadas.

Management The lack of drainage in the low-lying centre of the Basin has caused widespread internal or external salinity. This and the high lime contents are the main limitations for good soil management. Both problems increase towards the centre and limit agriculture despite the favourable relief for machinery and irrigation. Relief, erosion, texture, nutrient status, structure and permeability are favourable for most soils. Their significance for agriculture is examined in Chapter 9.

4.2 Mapping units

Systematics and nomenclature The highest category on the soil map (App. 1) is the *landscape* (equivalent to the broad soil association) based on geomorphology and geogenesis (Chapter 2), e.g. Uplands, Terraces and Alluvial Plains. The landscapes are divided into *soil associations,* groups of geographically related taxonomic units (Soil Survey Manual, 1951, p. 303). In a semi-detailed survey published on the scale 1 : 100 000 as of the Çumra Area (Driessen & de Meester, 1969) a soil association can be subdivided into distinct taxonomic units such as soil series. They and their constituent phases can be designated *mapping units.*

For a reconnaissance survey (publication scale 1 : 200 000), however, the soil associations are subdivided directly into mapping units. These units may sometimes represent a taxonomic series but usually contain undefined series and their phases. The true composition of such units and a description of the components and their distribution will be illustrated by large-scale maps of small *sample areas* (App. 2). Details of units in the Çumra Area are described in the mentioned publication. The mapping units on the reconnaissance map are based on important profile characteristics. Those of practical importance for agriculture were preferred to genetic ones. An attempt was made to relate the mapping units to the new United States classification (Chapter 8) but as each unit represents a complex of taxa no mention is made of it in the unit descriptions.

The *legend* of App. 1 the Soil Map, is repeated in the detailed unit descriptions in Chapter 5. The unit names are not descriptions but identification symbols or tags and usually mention only texture. Soil colour, slope, topography, stoniness, soil depth and nature of subsoil are mentioned in the legend only to distinguish them from other mapping units. The nature of the subsoil is mentioned if the surface soil is shallow (0–40 cm) or very shallow (0–20). Soil depth is not mentioned if the soils are deeper because it is presumed that this hardly affects plant growth.

Soil salinity, marshy conditions and several topographic features (clay dunes, springs) are omitted from the legend but are indicated on the soil map by symbols (See next section).

Most of the terminology in the legend is based on the Soil Survey Manual (1951). The main deviations are bajada and colluvial which are used as defined by Thornbury (1965) (See section 2.2).

4.3 Map symbols

Some features have to be represented out of proportion on a map of 1 : 200,000 as symbols (See App. 1). Their presence may be of importance, especially if they are abundant or form a regular pattern. The symbols are mostly conventional symbols (Soil Survey Manual, 1951, Plates 1–7). The significance and nature of several are discussed below.

A *soil boundary* is drawn with a solid line 0.3 mm wide. On the scale used this represents a strip of 60 m. Very few soil characteristics change so sharply. Sometimes a transition between mapping units takes several hundred metres and cannot be mapped separately in a reconnaissance survey. *Uncertain soil boundary*: where the transition is extremely vague or uncertain, it is represented with a broken line.

Escarpments are abrupt changes in level. Very often they are also soil boundaries (valley sides or lake shores) but sometimes the soil does not change much as in the Terraces, where escarpments may have formed by tectonic forces. Escarpments are indicated in four different ways. Fig. 8 is an example of an escarpment 'steep, higher than 10 m'.

Dolines are large potholes or circular depressions, sometimes filled with water, caused by karst phenomena.

Ridges, mostly of sand or gravel are widespread. They form the soil association Lr.

Small sand dunes, *hummocks* (Fig. 56) and *blowouts* are often associated because they result from wind erosion. Blowouts are elongated depressions without vegetation.

Clay dunes are formed of pseudosand. This is clay in particles with the size of sand, which behave like blowing sand. Clay dunes occur near the vast clay plains, whose surface crust tends to fragment by a mechanism induced by salinity. Mapping Unit AbE presumably is formed in such a way as well.

Brick factories are indicated because their presence suggests a clay of kaoline or illite type suitable for brickmaking.

Ancient habitation mounds (Turkish: Höyük) are the remains of ancient dwellings. Some are Neolithic (Çatal Höyük, Çumra Area) but most are younger, often Roman or Byzantine. In cross-section, the mounds consist of a number of successive habitation layers (Mellaert, 1964). The soil of the höyük is extremely rich in phosphorus. Because of their archaeological values, they are usually not cultivated. Their distribution over the Basin and the depth of virgin soil underneath them, may give valuable information on the history of geogenesis, vegetation and land-use.

4.4 System of description

The legend acts as an index to the arrangement of the mapping units in Chapter 5. The fulness of the descriptions depends on the thoroughness with which they have been studied. Some soils have been the subject of special studies, e.g. the Bajada Soils, the Backswamp Soils and the Marl Soils (De Meester & Van Schuylenborgh, part B; Van der Plas & Schoorl, part B; de Meester, 1971).

Each description will open with a general description of the landscape's soils to avoid repetition of common features. The unit descriptions describe first the soil characteristics in the following order:

Colour and texture
Structure and depth of profile
Drainage and salinity
Special features
Uniformity of unit (range of characteristics)
Geographic occurrence
Land-use and capability
Characteristic profiles and analytical data.

Profile descriptions some with a photograph of a soil peel and analytical data are included. The profile sites are indicated on the Soil Map (App. 1).

Inferences are made about productivity, fertility, erodibility, drainage and yield.

Sample areas in various parts of the Basin have been surveyed in detail to obtain information on the composition of important units. The results will be used now, by producing small maps which show this composition (see App. 2). More information than this would make the description too lengthy. However, detailed information on several areas is published. In fact, the Çumra Area (Driessen & de Meester, 1969) and the Karapınar area (Groneman, 1968) were very large sample areas.

4.5 Terminology

The most common terms are the following:

Soil depth, independent of composition and origin:	
surface soil	plough layer
subsurface soil	solum
subsoil	soil below the solum, usually parent material
Soil depth relative to underlying material:	
very shallow soils	< 20 cm deep
shallow soils	20– 40 cm deep
moderately deep soils	40– 80 cm deep
deep soils	80–120 cm deep
very deep soils	> 120 cm deep
Soil texture:	
sandy soils:	
sand	coarse-textured
loamy-sand	moderately coarse-textured
sandy-loam	moderately coarse-textured
fine-sandy-loam	moderately coarse-textured
loamy soils:	
loam	medium-textured
silt-loam	medium-textured
silt	medium-textured
clayey soils:	
clay-loam	fine-textured
sandy-clay-loam	fine-textured
silty-clay-loam	fine-textured
sandy-clay	fine-textured
silty-clay	fine-textured
clay	fine-textured
heavy-clay	fine-textured
Porosity:	
mesopores	soil pores 30–100 μm, visible at $\times$ 10 magnification
macropores	soil pores > 100 μm, visible with the naked eye
biopores	pores formed by biological activity.

5 Description of mapping units

5.1 Discussion of the soil pattern from the map

A quick look at the Soil Map (App. 1) shows the division of the Great Konya Basin into a western and an eastern part, separated by the sandy area near Karapınar.

The western part consists of 2 subbasins filled with carbonatic clay, with marshes in their lowest spots; the eastern part also has two subbasins with carbonatic clays, but with very saline playas in their centre. A long wide valley drains into the easternmost subbasin from the direction of Bor in the north-eastern corner.

The Lacustrine subbasins are surrounded by Colluvial and Bajada Soils. Terrace Soils occur in patches all over the surveyed area, but are concentrated at the border.

The *Konya Area* (see Fig. 1) shows the typical distribution of soils. The Alluvial Meram and Sille Fan Soils (Ak) spread eastward over the plain and have a characteristic base zone of Marsh Soil (MfC). The lowest part of the Konya subbasin is between Yarma and Karakaya (997.5 m).

The *Çumra Area* is entirely dominated by the Çarşamba Fan Soils (Ac). This delta spreads over the Lacustrine Plain but former lake shores stand out as an almost continuous belt of sandriges and beaches (LpA). Some 10 km north of Çumra the river has broken through a large sandridge.

The Çarşamba Fan is composed of two segments. The northern segment shows a normal sequence of loamy, clayey and heavy-clay soils from apex to base. The eastern part was presumably once a spillway for torrential floods and has a complicated pattern of clayey and sandy soils. North-east of the fan, around Demirkent, sandridges (Lr) and sandy Marls (LmB) form the boundary with the north-eastern Konya subbasin.

South of Çumra are Terraces (Te) in a characteristic pattern. The lowest visible is near Ürünlü. They form a series of wide plains at increasing levels and each more eroded than the next down. A beach (Lp) has been deposited against the 1015 m escarpment. The escarpments presumably result from rock structure and faults.

The beach near Arikören ends in several parallel sandridges presumably indicating a period of fluctuating lake level.

The western part of the *Karaman Area* is mainly Bajadas (Br) and Undulating Terrace Soils (ThA). The soil pattern shows clearly that the Bajadas are erosion products from the Limestone Uplands and from the upper Terraces. Detailed surveys of the Bajadas reveal that the lowest areas are filled with heavy-clay washed out from the surroundings. Such repeated sedimentation is common in arid zones.

The Çamurluk Fan (Aa) is peculiar because of its carbonatic pale-brown soils, which presumbaly originate mainly from unconsolidated Tertiary marls in the uplands, south of Karaman.

There is a Lacustrine Plain with Marl Soils (Lm) in the north-eastern part of the Karaman Area. Its marshes are fed with seepage water from the fan and contain thick dark clay in their lowest spots. This subbasin must have been connected once with the Hotamış Basin and the Ak Göl Basin. Later it was sealed off in the north near İşlik by several sandridges and in the east by the Ayran lower Fan (As).

The *Hotamış Area* has lacustrine Marl Soils located in a basin communicating with Hotamış Gölü. The lowest part used to be flooded in winter and spring and the marshy conditions in the centre gave rise to dark Marl Soil (LmC). This subbasin is bordered on three sides by Terraces which have produced little or no colluvial or alluvial material. The Terraces near Hotamış and near Apak form peculiar capes, leaving little connection with parts of the Basin north and south-east of Karapınar.

The west of the Hotamış Basin is enclosed by sandridges near Demirkent.

The *Karapınar Area* has a complicated and irregular soil pattern, comprising a body of sand south of the town, a saline subbasin north of it and volcanic ash in the east. The easternmost part of the Karapınar Area is formed by the saline Ak Göl subbasin.

The Sandy Dunes (Dd) have a characteristic pattern. The direction of movement can clearly be derived from their shape. Much of the Sandplain (Lp) has a hummocky topography as result of specific weather conditions.

The two subbasins or depressions have no certain source of water supply and dry out completely in summer. The soils apparently have never been marshy. Instead the soils are playas with a thick saltcrust (LmE).

The Ak Göl depression has 'tertiary' basins surrounded by escarpments formed by abrasion when flooded in winter. The depressions have been further blown out in summer to form a narrow belt of sand dunes north of it. The present Ak Göl contains water permanently and acts as drain or reservoir for tailwater from the Zanopa Fan and other sources. It has numerous inexplicable islands.

The Ereğli Area is dominated by the River Zanopa which has formed Alluvial Fan Soils (Ag) with a characteristic simple pattern.

Its loamy and sandy valley is relatively short and wide and ends in a beautifully shaped fan with clayey soils. The present river-course is east of the fan. The well drained clay soils towards the fan's base are bordered by a belt of Marshes with waterlogged clay and this by a belt of wells and springs, resulting in a wide area of Marsh Soils (Mf) with organic and limey soil. A number of villages forms a perfect semicircle through the zone of wells.

The northern part of the Ereğli Area and of the Karapınar Area has Volcanic Bajada Soils (Bv), which give smooth slopes of sandy and porous volcanic material with hardpans and cemented surfaces locally. Within the Volcanic Uplands, depressions occur with clayey Volcanic Soils (BvB).

The Sandridges near Hortu (LrA) indicate the approximate easternmost limit of the Marl Soils (Lm).

The eastern part of the Ereğlı Area and the entire *Bor Area* form the broad valley leading from Bor to the Ak Göl subbasin.

The central part of this valley has saline Soft Lime Soils (TcA) presumably formed from decomposed Neogene limestone, enriched by precipitation of lime from groundwater rich in bicarbonates entering from the sides of the valley.

This plain has a dense pattern of drainage gullies indicating its function to transport excess surface water from the eastern catchment area to Ak Göl.

North of the central valley are Volcanic Bajada Soils (BvB) and an Alluvial Fan (AnA). South of it are Limestone Bajadas (Br). South-west of the road, these Bajadas are gravelly (BrD), being Tertiary rubble deposits, at present partly redeposited whereas east of the road in the Bor area, clayey reddish-brown bajadas (BrA) occur, derived from red Mediterranean-weathered limestones.

South-west of Bor, a clayey Alluvial Fan occurs (Ah), with a very saline base, merging into an area with expanding, black backswamp clays (AbA).

Mainly along the southern border of the Basin and around the Karadağ Massif Medium Sized Fans or cones with coarse-textured soils occur (Au). Where several such fans emerge from the uplands close together, their deposits coalesce and form a Bajada. If so, the fans are often too small to be mapped separately.

North of the road near Merdiven Yayla (Hotamış Area north) there is a peculiar soil pattern of undulating and flat structural terraces covered with a sand sheet. Locally even mobile dunes have formed. These Old Sandplain Soils (Lo) are lacustrine but have no connection with the late Pleistocene lacustrine system and are presumably early Pleistocene or Tertiary. The relief of this sandplain follows that of the underlying terrace.

All round the Basin a narrow strip of Colluvial Soil (Cr or Cv) marks the boundary between the Plain and the Uplands. Its outline is jagged because it follows the sides of valleys entering the Basin. This forms the limit of the surveyed area.

5.2 U Uplands

The soils of the surrounding Uplands were not included in the survey but a general description is necessary because most of the soils in the Basin are products of their erosion. Apart from the volcanic central Karadağ Massif and the majority of the Uplands between Karapınar and Bor, they are mostly limestone. Two associations are distinguished, each with two units.

Ur Limestone Upland Soils

UrA Shallow angular-cobbly loamy or rocky

UrB Conglomerates or breccias, locally not consolidated

Uv Volcanic Upland Soils

UvA Angular-cobbly pumice and ash, or rocky

UvB Volcanic cones

UrA Shallow angular-cobbly loamy or rocky is a complex of shallow brown angular-cobbly loams on limestone and bare limestone. Most of the limestone is Tertiary and the higher parts are entirely denuded. The composition of the complex depends very much on relief. The eroded soil has collected on level spots, on lower slopes and in cracks. South of Konya and Bor the products of weathering are reddish-brown, similar to red Mediterranean soil. The deeper soils support a good vegetation because they are moist, well drained and never saline. They may therefore provide useful grazing. Locally even small cultivated fields are seen.

South of Konya and near Erentepe (Karaman Area West) small patches of ultra-basic rock occur. As they are mixed with limestone and produce almost similar products on weathering, they have been included in this unit but are indicated on the soil map by the word ultrabasic.

UrB Conglomerates or breccias, locally not consolidated, is a complex of gullied formations, presumably Tertiary debris cones. Upper parts are very stony or cobbly; lower parts and depressions are clayey. Relief is excessive. Consolidated conglomerates or breccias occur in the north-west of the Konya Area. Unconsolidated debris hills up to 1500 m high occur east of Ereğli. Their erosion products collect downhill almost unchanged as Colluvium and Bajadas. Boundaries are based mainly on stoniness, relief and slope.

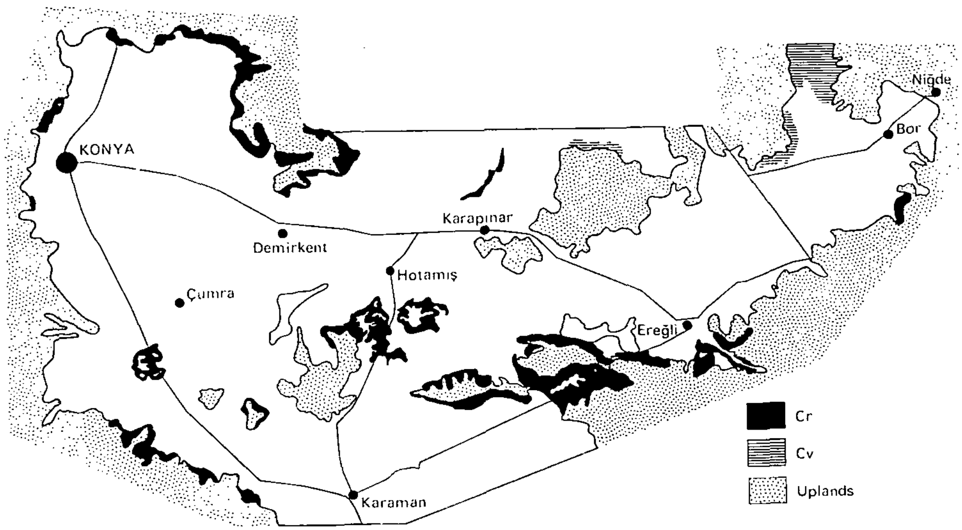
UvA Angular-cobbly pumice and ash, or rocky is a complex of dark-brown angular-cobbly volcanic sands and loams. Moderately deep soils in depressions alternate with bare volcanic rock. The soils are rapidly permeable and subject to rill erosion but grazing is possible on the camelthorn (*Alhagi camelorum*) of lower slopes. Here and there the soil is strongly salt-affected as near crater lakes and old dry craters.

UvB Volcanic cones (Fig. 3) are mapped as separate units to make them stand out and because they have deep but, because of the steep slopes, severely eroded soils.

5.3 C **Colluvial Slopes** (Fig. 21)

The upper footslopes of Limestone or Volcanic Uplands are often covered with erosion products which have been transported by gravity. Lower down the slopes are gentler and deposits have been transported by running water. 'Colluvial Soils' here cover deposits transported mainly by gravity (Thornbury, 1965) and occur on moderately steep slopes as narrow strips (wider on the ground than on the orthogonal

Fig. 21. Distribution of Colluvial Soils from limestone (Cr) and from volcanic rock (Cv).



Şekil 21. Kireç taşından (Cr) ve volkanik taşlardan meydana gelen koluviyal toprakların dağılımı.

projection of the map!). They mark the transition from Uplands to plain. Steeper slopes or strips too small to be marked are included in the Uplands. Small colluvial (or allivial) fans at the foot of large erosion gullies are indicated by a symbol of radial lines.

In some places with low hills, as north-east of the Karadağ Massif or north of the Aryan Barrage (Karaman Area), the colluvial material fills up small valleys. Such areas are level rather than sloping.

Two associations are distinguished, each of one unit.

Cr Limestone Colluvial Soils

CrA Angular-cobbly moderately steep sandy or loamy

Cv Volcanic Colluvial Soils

CvA Angular-cobbly moderately steep pumice and ash.

CrA Angular-cobbly moderately steep sandy or loamy are deep dark-brown (10YR 4/3) to yellowish-brown (10YR 5/4) well drained saltfree loams or locally sands. A calcic horizon, sometimes cemented, is common. There is little variation, except in stoniness and slope. Locally rock outcrops. Although the strips are small, many are cropped with wheat (Fig. 22) or grapes. Unless too steep, the soils are moistened for most of the year by seepage from the Uplands. They are highly erodible.

Fig. 22. Cultivated Bajada Soils (BrA). In background cultivated Colluvial Soils (CrA) on the footslopes of a denuded limestone hill (UrA).

Şekil 22. Sürülü Bajada toprakları (BrA). Arka plânda sürülü kireçtaşı koluviyal toprakları (CrA), taban eğimlerde aşındırılmış bir kireçtaşı tepesi (UrA).

CvA Angular-cobbly moderately steep pumice and ash are deep gray-brown angular-cobbly to loamy or sandy soils without any visible horizons and often containing limestone fragments or windblown sand over volcanic rock. They are usually well drained and usually saltfree, but locally salt of volcanic origin may accumulate. They occur in small units in the Karapınar and Ereğli areas, on the slopes of the Karadağ Massif and other isolated volcanic cones. Their texture and high erodibility make them less frequent on steep slopes than is Limestone Colluvium. Many volcanic footslopes have therefore been mapped as Volcanic Bajada Soils (Bv) rather than as Volcanic Colluvial Soils. Very steep areas are included in the unit Volcanic Cones (UvB).

5.4 T **Terraces** (Fig. 23)

Much of the south and west of the Basin, and the north of the Hotamış Area consists of horizontally stratified Neogene limestones. The different levels of these level or gently sloping terraces are caused by subsidence or uplift along faults. The lowest Terraces (Tc) have presumably been abraded flat by the ancient lake. The highest Terraces (Th) have been eroded into an undulating landscape. Besides normal gullies, the Terraces are in several places (especially south of Çumra) dissected by wide and almost straight dry Gullies (Tg) which must have been cut in the Pleistocene Period.

The Terraces consist of 4 associations and 10 units.

Te Flat Terrace Soils

- TeA Loamy or clayey, soft lime subsoil over limestone
- TeB Loamy or clayey over limestone
- TeC Eroded loamy or clayey, locally stony or shallow
- TeD Volcanic, locally shallow loamy, soft lime subsoil over limestone

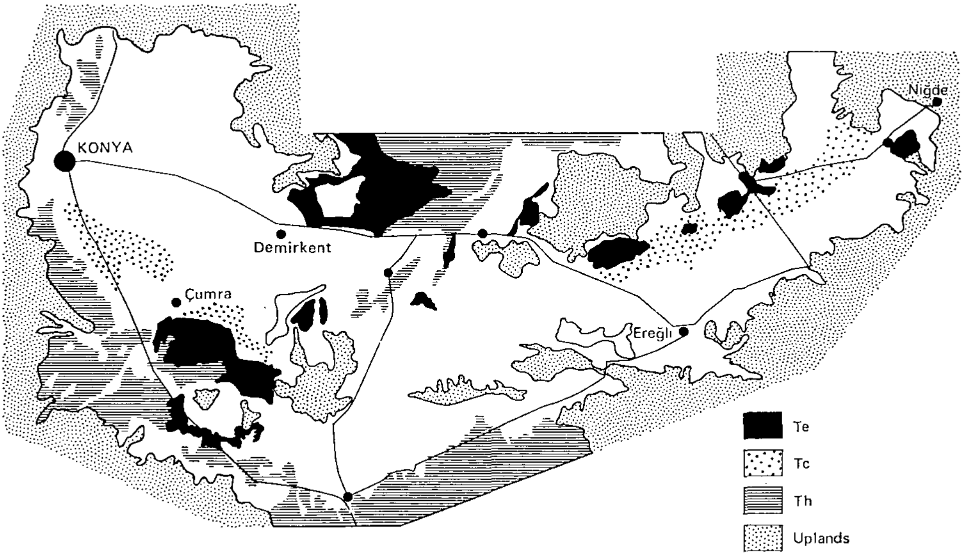
Th Undulating Terrace Soils

- ThA Angular-cobbly, locally very shallow clayey over limestone
- ThB Eroded angular-cobbly, predominantly very shallow over limestone

Tc Soft Lime Soils

- TcA Locally very shallow loamy or clayey over soft lime
- TcB Locally very shallow loamy or clayey over concreted white lime
- TcC Locally very shallow loamy or clayey over limestone

Fig. 23. Distribution of Undulating Terrace Soils (Th), Flat Terrace Soils (Te) and Soft Lime Soils (Tc).



Şekil 23. Ondüleli Teras Toprakları (Th), Düz Teras Toprakları (Te) ve Yumuşak kireç toprakları (Tc) 'nın dağılışları.

Tg Terrace Gully Soils

TgA Shallow clayey over limestone, including rocky slopes

TeA Loamy or clayey, soft lime subsoil over limestone (Figs. 24 and 25, Profiles 1, 2 and 3 and Table 3) are deep or moderately shallow brown (7.5YR 4.5/4) subangular

Profile 1.
Profil 1.

TeA loamy or clayey Flat Terrace Soils, soft lime subsoil over limestone

Great Konya Basin, Çumra Area, 54.8 N, 86.2 E, alt. about 1020 m, 24–6–1965, (Peters)

Geomorphology: terrace
Parent material: calcareous loam or clayloam
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: well drained, watertable deeper than 6 m
Moistness: dry
Salinity: saltfree
Biology: roots plentiful down to 50 cm, few to 130 cm, wormholes down to 130 cm
Land-use: dry-farming
Classification: 1964 Typic Calciorthid
1967 Typic Calciorthid

Soil description of Profile 1.

A1	0– 45 cm	brown to dark-brown (10YR 4.5/3) loam, brown to pale brown (10YR 5.5/3) when dry; fine weak subangular-blocky structure; slightly hard when dry, sticky when wet; few macropores, many mesopores; few lime concretions smaller than 2 mm; clear smooth boundary.
B1ca	45–100 cm	pale brown (10YR 6/3) loam, very pale-brown (10 YR 7/3) when dry; weak fine subangular-blocky structure, slightly hard when dry; sticky when wet; few macropores; many mesopores; common distinct fine lime mottles; common concretions smaller than 5 mm, few large wormholes; gradual wavy boundary.
B2ca	100–130 cm	pale brown (10YR 6/3) loam, very pale brown (10YR 7/3) when dry; weak fine subangular-blocky structure, slightly hard when dry, sticky when wet; many macropores, many mesopores; common distinct medium lime mottles; many concretions of lime; few wormholes; diffuse irregular boundary.
C1	130–158 cm	very pale-brown (10YR 7/3) loam, similar (10YR 8/3) when dry; weak medium angular-blocky structure; very hard when dry, sticky when wet; many macropores and mesopores, gradual wavy boundary.
C2	158–198 cm	very pale-brown (10YR 8/3) loam, white (10YR 8/2) when dry, weak medium angular-blocky structure; very hard when dry, sticky when wet; many macropores and mesopores; some gravel; gradual wavy boundary.
IIC1	198–231 cm	same colour as C2, very hard and massive when dry or wet; many big irregular-shaped stones, diameter greater than 5 cm.
IIC2	231–320 cm	same colour as C2, very hard and massive when dry or wet; many round pebbles smaller than 5 cm;
R	> 320 cm	hard limestone rock.

This profile has an ochric epipedon and a calcic horizon.

loam or clay with solid limestone at about 150 to 200 cm. They are well drained (have medium or rapid internal drainage) and the upper layers are saltfree (Chapter 6). The age of the soils is shown by the pronounced colour and structural B horizon, distinct calcic horizon, often above gypsic and salic horizons. Below them at 100 or 150 cm is a layer of almost white soft lime about 100 cm thick, specific for this unit. It is presumably old and much weathered limestone debris, now much disturbed and broken by burrowing animals such as the ground-squirrel (*Citellus* sp.) and the blindmouse (*Spalax* sp.) (de Meester, Part B). However genesis by lateral lime enrichment has not been excluded. Below the soft lime is a gypsum-rich brown layer before limestone bedrock. They are flat except for a few Terrace Gullies (TgA).

The unit is fairly uniform but near Yağmurlar they are truncated to a shallow surface soil over the soft lime. Elsewhere there are gravelly or cherty spots. The large expanses in the Çumra and Karaman areas are the second-best agricultural lands of the Basin. Only small parts are irrigated.

Profile 2.
Profil 2.

TeA Loamy or clayey Flat Terrace Soils, soft lime subsoil over limestone

Great Konya Basin, Karaman Area, 31.0 N, 99.4 E, alt. about 1027 m, 19–6–1967 (Ruessink)
Geomorphology: structural terrace
Parent material: calcareous loam
Relief and slope: subnormal, nearly level
Stoniness: Class 0
Hydrology: somewhat excessively drained, watertable deeper than 10 m
Moistness: dry
Salinity: saltfree
Biology: 0–20 cm, common medium and fine roots; 20–32 cm, common fine roots
Land-use: dry-farming, wheat
Classification: 1964 Petrocalcic Calciorthid
1967 Typic Paleorthid

Soil description of Profile 2.

Ap	0–19 cm	yellowish-brown (10YR 5/4) loam, 10YR 6/4 when dry, with a moderate fine and medium subangular-blocky and fine crumb structure; soft; common mesopores and macropores; clear smooth boundary.
B1	19–30 cm	yellowish-brown (10YR 5/4) loam, 10YR 7/4 when dry, with a moderate, fine and medium subangular blocky structure; slightly hard; common mesopores and macropores; abrupt smooth boundary.
B2ca	30–39 cm	laminated indurated calcium carbonate.
B3	39–52 cm	yellowish-brown (10YR 5/4) loam, 10YR 7/4 when dry, with a moderate fine and medium subangular-blocky structure; slightly hard; common mesopores and macropores; clear smooth boundary.
C	more than 52 cm	Soft lime.

This profile has an ochric epipedon and a petrocalcic horizon

TeB Loamy or clayey over limestone (Profile 4) are deep brown predominantly loamy or clayey soils resembling TeA but more reddish and generally lacking the layer of soft lime. The solum rests directly on limestone, which is rotten in the contact zone. The terrain is nearly level. They are uniform in their main characteristics. They occur south of Çumra and in the Hotamış Area. Their excellent physical properties and flatness fit them well for agriculture. None have been irrigated.

Profile 4.
Profil 4.

TeB Loamy or clayey Flat Terrace Soils over limestone

Great Konya Basin, Hotamış Area, 77.2 N, 125.8 E, alt. 1015 m, 14–7–1965 (Gülağa Şimşek, Peters, Winkelmolen)

Geomorphology: structural terrace
Parent material: calcareous sandy loam
Relief and slope: flat, slightly hummocky surface
Stoniness: Class 0
Hydrology: somewhat excessively drained, watertable deeper than 10 m
Moistness: dry
Salinity: saltfree
Biology: moderately rooted until 50 cm, few roots below 50 cm, wormholes
Land-use: ranging
Classification: 1964 Typic Durorthid
1967 Typic Durorthid

Soil description of Profile 4.

A1	0– 6 cm	brown (10YR 4/3) sandy loam, very pale-brown (10YR 7/3) when dry; weak fine granular structure; soft when dry, friable when moist, slightly sticky when wet; wet; common macropores and many mesopores; distinct pseudomycelia near roots, some gravel, many wormholes filled with excrements; abrupt smooth boundary.
B1	6–29 cm	brown (10YR 5/3) sandy loam, very pale-brown (10YR 7/3) when dry; weak fine subangular-blocky structure; slightly hard when dry, friable when moist, slightly sticky when wet; few macropores and common mesopores; pseudomycelia near roots, gravel, wormholes filled with excrements; clear smooth boundary.
B21	29–42 cm	pale-brown (10YR 7/2) sandy loam; very weak fine subangular-blocky structure; slightly hard when dry, friable when moist and slightly sticky when wet; few macropores and mesopores; wormholes with excrements; abrupt irregular boundary.
B22	42–70 cm	very pale-brown (10YR 7/3) hardpan, light-gray (10YR 7/2) when dry; abrupt irregular boundary.
C	70–90 cm	pale-brown (10YR 6/3) loamy sand, very pale-brown when dry; very weak fine subangular-blocky structure; slightly hard when dry, very friable when moist, non-sticky when wet; few macropores and mesopores; abrupt smooth boundary.
R	> 90 cm	Hard limestone rock.

This profile has an ochric epipedon, a cambic horizon and a petrocalcic horizon.

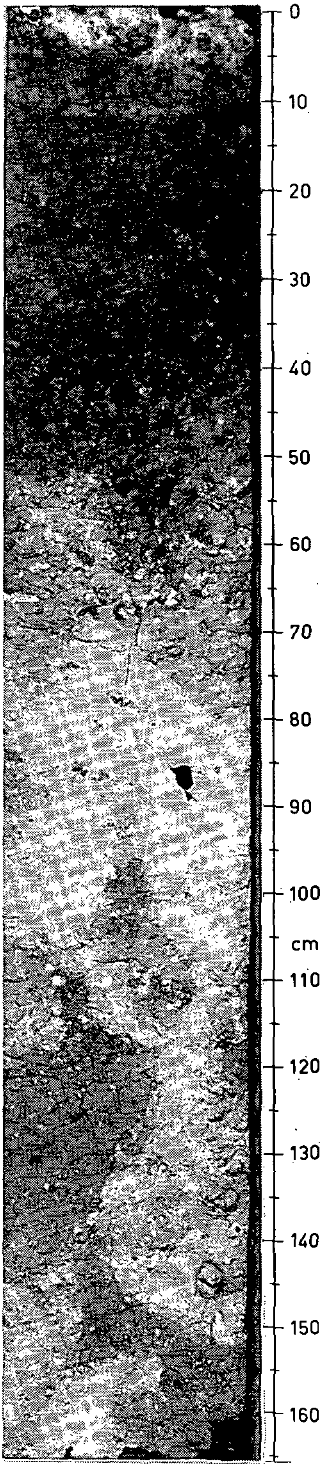


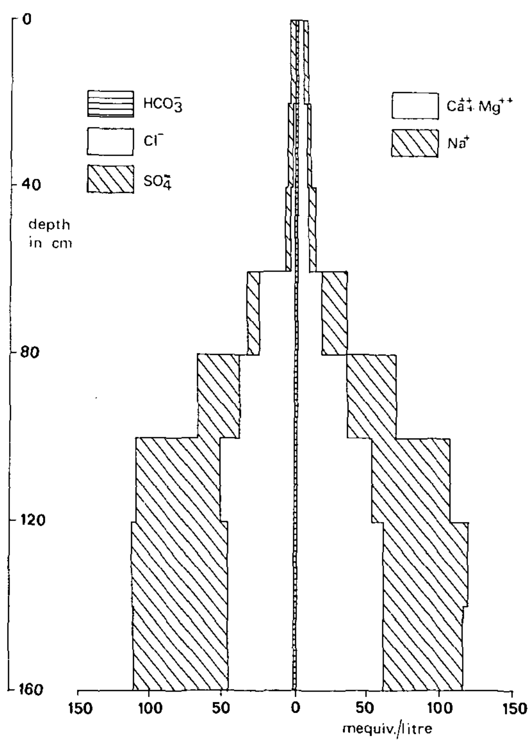
Fig. 24. Profile no 3.
Şekil 24. Profil no. 3.

TeA Loamy or clayey Flat Terrace Soils, soft lime subsoil over limestone

Great Konya Basin, Çumra Area, 54.2 N, 85.0 E, alt. 1015 m, 3–9–1964 (de Meester & Bannink)

Geomorphology: structural terrace
Parent material: calcareous clay-loam
Relief and slope: flat, nearly level
Stoniness: Class 0
Hydrology: well drained, watertable deeper than 5 m
Moistness: dry
Salinity: saltfree
Biology: few fine roots, mainly in krotovinas
Land-use: dry-farming
Classification: 1964 Mollic Calciorthid
1967 Mollic Calciorthid

Fig. 25. Ionbalance of Profile no 3.



Şekil 25. Profil no. 3 de iyon denegsi.

Table 3. Analytical data of Profile 3

Horizon	Depth (cm)	Particle-size distribution						$CaCO_3$ eq. (%)
		< 2μm		2–50μm		> 50μm		
		$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	
Ap	5– 15	70.4	31.1	12.4	44.9	17.2	24.0	24.1
B21ca	30– 40	50.5	41.8	36.5	38.8	14.0	20.0	25.4
B3ca	65– 75	66.1	40.4	21.4	39.6	12.5	20.2	39.5
C1ca	95–105	63.0	45.5	28.9	48.7	8.2	7.0	67.1
C2ca	125–135	55.9	43.1	34.1	50.0	10.0	6.9	61.9
C2ca	155–165	71.1	49.4	22.8	43.6	5.5	7.7	63.6

Depth	pH	ECe (mmho/cm)	CEC (meq/100 g)	ESP
0– 20	8.03	0.65	17.7	1.41
20– 40	7.91	0.74	–	–
40– 60	7.99	1.13	–	–
60– 80	8.05	3.71	10.2	6.54
80–100	8.29	6.36	–	–
100–120	8.34	9.23	–	–
120–140	8.31	9.42	11.36	7.92
140–160	8.21	9.28	–	–

All analyses of this and other profiles were carried out by the laboratories of the Agricultural University of Wageningen (see 'Participants in the Konya Project'). Most methods are according to Handbook 60 (Diagnosis,1954). Dispersion of calcareous soils was done with sodium hexametaphosphate.
$+CaCO_3$ means lime not removed.
$-CaCO_3$ means lime removed with HCl.

Tablo 3. Profil 3'e ait analitik bilgiler.

Soil description of Profile 3.

Ap 0– 12 cm brown (10YR 5/3) clay-loam, pale-brown (10YR 6/3) when dry; moderate medium subangular-blocky structure mixed with fine granular material; slightly hard and loose when dry, slightly sticky and slightly plastic when wet; many macropores and mesopores; few fine distinct lime concretions; clear smooth boundary.

B21ca 12– 39 cm yellowish-brown (10YR 5/6) clay-loam, pale-brown to brown (10YR 5.5/3) when dry; strong coarse subangular-blocky structure; hard when dry, slightly sticky and plastic when wet; many macropores and mesopores; common fine distinct pseudo mycelia and common medium distinct white lime nodules; gradual wavy boundary.

B22ca 39– 51 cm yellowish-brown (10YR 5/6) clay-loam, pale-brown to brown (10YR 5.5/3) when dry; strong coarse subangular-blocky structure; hard when dry, slightly sticky and slightly plastic when wet; many macropores and mesopores; many medium distinct white lime nodules and many medium distinct pseudomycelia; diffuse wavy boundary.

B3ca 51– 68 cm as above but lighter in colour and common medium distinct soft lime pockets and nodules; diffuse boundary.

C1ca 68–103 cm light-gray (10YR 7/2) lime, white (10YR 8/2) when dry; structureless massive; very hard and weakly cemented when dry, slightly sticky and slightly plastic when wet; many macropores and few mesopores; some krotovinas: light-yellowish-brown (10YR 6/4) calcareous loam, light-gray (10YR 7/2) when dry; weak fine and very fine subangular-blocky; soft weakly cemented when dry, slightly sticky and slightly plastic when wet; many macropores and mesopores; many fine hard distinct lime nodules; diffuse boundary.

C2ca 103–168 cm as above but with more and bigger krotovinas with similar characteristics.

This profile has an ochric epipedon, a cambic and a calcic horizon.

Profile 5.
Profil 5.

TeC Eroded loamy or clayey Flat Terrace Soils, locally stony or shallow

Great Konya Basin, Çumra Area, 50.6 N, 88.6 E, alt. about 1030 m, 4–7–1965 (Peters)

Geomorphology: structural terrace
Parent material: calcareous clay-loam
Relief and slope: flat, nearly level, locally undulating
Stoniness: Class 2
Hydrology: well drained, watertable deeper than 10 m
Moistness: dry
Salinity: salt free
Biology: Until 70 cm moderately rooted, deeper few roots, wormholes
Land-use:dry-farming
Classification: 1964 Typic Calciorthid
1967 Typic Calciorthid

Soil description of Profile 5.

Ap 0– 13 cm dark-brown to brown (7.5YR 4/4) loam, brown (7.5YR 5/4) when dry; moderate very fine subangular-blocky structure; soft when dry, very friable when moist, sticky and non-plastic when wet; few macropores, common mesopores; few large wormholes; abrupt smooth boundary.

AB 13– 49 cm dark-brown to brown (7.5YR 4/4) clay loam, same colour when dry; moderate fine subangular-blocky structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; few macropores, common mesopores; common prominent fine lime mottles; few large wormholes, few fine lime concretions; gradual smooth boundary.

B1ca 49– 71 cm dark-brown to brown (7.5 YR4/4) clay-loam, light-brown (7.5YR 6/4) when dry; moderate fine subangular-blocky structure; hard when dry, friable when moist, sticky and nonplastic when wet; common macropores and mesopores, many distinct medium lime mottles; many lime concretions; gradual smooth boundary.

B2ca 71– 94 cm light-brown (7.5YR 4/4) clay-loam, pinkish-gray (7.5YR 6.5/2) when dry, moderate fine subangular-blocky structure; hard when dry, friable when moist, sticky and non-plastic when wet; few macropores, common mesopores; many faint coarse lime mottles; little gravel, many concretions, many large krotovinas; clear smooth boundary.

IIC1 94–140 cm reddish-yellow (7.5YR 6/6) clay-loam, light-brown (7.5YR 6/4) when dry; weak very fine subangular-blocky structure; sightly hard when dry, very friable when moist, slightly sticky, slightly plastic when wet; few macropores and mesopores; common faint coarse lime mottles; many krotovinas, many filled pores; gradual smooth boundary.

IIC1cs 140–155 cm reddish-yellow (7.5YR 6/6) clay-loam, light-brown when dry (7.5YR 6/4) moderate fine angular-blocky structure; slightly hard when dry, very friable when moist, slightly sticky and non-plastic when wet; few macropores, few mesopores; very hard crystal clusters of gypsum, many filled pores; gradual smooth boundary.

IIC2cs > 155 cm reddish-yellow (7.5YR 6/6) clay-loam, light-brown (7.5YR 6/4) when dry; moderate fine angular-blocky structure; slightly hard when dry, very friable when moist, slightly sticky and non-plastic when wet; few macropores and mesopores; many filled pores, black spots of manganese.

This profile has an ochric epipedon, a calcic horizon (uncertain) and a gypsic horizon.

Profile 6.
Profil 6.

TeC Eroded loamy or clayey Flat Terrace Soils, locally stony or shallow

Great Konya Basin, Ereğli Area, 83.0 N, 204.0 E, alt. about 1048 m, 14–8–1967 (Ruessink)

Geomorphology: structural terrace
Parent material: calcareous loam
Relief and slope: subnormal, level to gently sloping
Stoniness: Class 1
Hydrology: well drained, watertable below 10 m
Moistness: dry
Salinity: saltfree
Biology: few fine roots up to 30 cm
Land-use: dry-farming, presently fallow
Classification: 1964 Typic Haplorthent
1967 Typic Xerorthent

Soil description of Profile 6.

Ap 0–23 cm brown (10YR 4.5/3) loam, pale-brown (10YR 6/3) when dry with moderate medium angular to subangular-blocky structure; slightly hard to hard when dry and slightly sticky and non-plastic when wet; few biopores, many mesopores and common macropores; gravel; clear and smooth boundary.

C1 23–60 cm brown to pale-brown (10YR 5.5/3) sandy loam, very pale-brown (10YR 7/3) when dry; structureless; soft when dry and slightly sticky and non-plastic when wet; few pores; gravel; abrupt and smooth boundary.

R > 60 cm limestone.

This profile has an ochric epipedon.

Profile 7.
Profil 7.

TeD Volcanic locally shallow loamy Flat Terrace Soils, soft lime subsoil over limestone

Great Konya Basin, Karapınar Area, 69.2 N, 173.0 E, alt. about 1030 m, 23–5–1966 (van den Eelaart)

Geomorphology: structural terrace
Parent material: volcanic and calcareous sandy loam
Relief and slope: normal, gently sloping
Stoniness: Class 1
Hydrology: well drained, watertable below 10 m
Moistness: dry
Salinity: saltfree
Biology: disturbed soil, biopores of all sizes and roots common throughout the profile
Land-use: dry-farming, wheat and rye
Classification: 1964 Andic Calciorthid
1967 Andic Calciorthid

Soil description of Profile 7.

A11	10– 15 cm	light-brown (7.5YR 6/4) volcanic gravelly sandy-loam with a weak very thick platy structure; slightly hard when dry, very friable when moist and slightly sticky and plastic when wet; many mesopores and macropores; no biopores; roots common; abrupt smooth boundary.
A12	15– 40 cm	light-brown (7.5YR 6/4) volcanic gravelly sandy-loam, massive and structureless; slightly hard when dry, friable when moist and slightly sticky and plastic when wet; common mesopores and macropores; roots common; abrupt wavy boundary.
C1ca	40– 65 cm	pink (7.5YR 7/4) gravelly loam; massive and structureless; hard when dry, friable when moist and slightly sticky and plastic when wet; small hard lime concretions and large white lime spots; common fine and medium biopores, common mesopores and macropores; roots and krotovinas common; clear wavy boundary.
C2	65– 75 cm	light-brown (7.5YR 6/4) gravelly loam; massive and structureless; slightly hard when dry, friable when moist and slightly sticky and plastic when wet; many fine biopores, common mesopores and macropores; common roots and common krotovinas; clear wavy boundary:
C3cs	75–110 cm	light-brown (7.5YR 6/4) gravelly loam; massive and structureless; slightly hard when dry, friable when moist and slightly sticky and plastic when wet; distinct gypsum veins; common mesopores and macropores; common roots and krotovinas; clear wavy boundary.
C4cs	110–120 cm	light-brown (7.5YR 6/4) gravelly loam; moderate thin platy structure; hard when dry, friable when moist and slightly sticky and slightly plastic when wet; few mesopores and macropores; few roots; distinct gypsum pseudomycelium; few distinct red iron mottles (2.5YR 5/6); clear wavy boundary.
	> 120 cm	indurated lime crust.

This profile has an ochric epipedon and a calcic horizon.

TeC Eroded loamy or clayey, locally stony or shallow (Profiles 5 and 6) are an eroded phase of TeB or locally of TeA. Their slightly higher level has caused erosion into gentle undulations and made the soils locally shallow over hard bedrock locally exposed. There is a structural B horizon and a calcic horizon. Higher parts are cherty. They are not uniform but a complex of moderately deep and shallow. They occur south of Çumra and in Hotamış Area north. They are suitable for agriculture but the relief hinders irrigation.

TeD Volcanic, locally shallow loamy, soft lime subsoil over limestone (Profile 7) has a typical TeA profile of deep brown loam with a calcic horizon, white soft lime subsoil over limestone but is covered with shallow volcanic ash and sandy-loam. They are well drained and saltfree. Terrain is nearly level. They occur only in the Ereğli Area north between Akviran and Kuzukuyu where a Neogene limestone terrace verges on the Volcanic Uplands. They are uniform except near Akviran, where volcanic material rests directly on limestone. They are dry-farmed with wheat and rye.

Th Undulating Terrace Soils are on the higher Terraces, usually at the Basin's border below the Uplands. They have been severely eroded into undulations with several deep gullies. Soil, removed partially or completely from the higher parts, was deposited in the depressions and gullies, whose deposits are very like Bajada. They are extremely complex, ranging from very shallow to moderately shallow, but usually shallow. The Undulating Terraces sometimes merge into Uplands and survey has been limited to exploration.

ThA Angular-cobbly, locally very shallow clayey over limestone (Profiles 8 and 9) are very shallow to moderately shallow commonly angular-cobbly olive-brown (2.5YR 4/4) or brown (7.5YR 4.5/4) calcareous clays often with a calcic horizon consisting of hard and soft lime segregations at 20 or 30 cm (unless the soil is too shallow). They are well drained and saltfree. The undulations make them complex. They occur in the west of the Basin and in the north of the Hotamış Area. They are mainly poor grazing but mainly in the depressions and valleys are small cultivated patches.

A deviant is a rolling area south-west of Yenisu (Karaman Area west) with moderately shallow and deep reddish-brown (5YR 4/3) to light-reddish-brown (5YR 6/4). Relief is excessive. This area is entirely dry-farmed.

Near Hotamış at about 1020 m (lower than usual) is a severaly eroded undulating area whose soils fit into this category.

ThB Eroded angular-cobbly, predominantly very shallow over limestone occur between Karaman and Ayrancı. They are eroded by deep gullies and many patches are denuded. Vegetation is poor grasses.

Profile 8.
Profil 8.

ThA Angular-cobbly locally very shallow clayey Undulating Terrace Soils over limestone

Great Konya Basin, Hotamış Area, 65.0 N, 128.0 E, alt. about 1000 m, 28–7–1958 (Peters & Winkelmolen)

Geomorphology: undulating structural terrace
Parent material: calcareous sandy loam
Relief and slope: normal, undulating
Stoniness: Class 0
Hydrology: very well drained, watertable deeper than 10 m
Moistness: dry
Salinity: saltfree
Biology: moderately rooted until 55 cm, few roots below
Land-use: dry-farming
Classification: 1964 Typic Calciorthid
1967 Typic Calciorthid

Soil description of Profile 8.

Ap	0–20 cm	olive-brown (2.5Y 4/4) sandy loam, light-brownish-gray (2.5Y 6/2) when dry; weak fine granular structure; soft when dry, very friable when moist and non-sticky and non-plastic when wet; few macropores and micropores; little gravel; abrupt smooth boundary.
ACca	20–55 cm	light-brownish-gray (2.5Y 6/2) sandy loam, light-gray (2.5 Y7/2) when dry; weak fine subangular-blocky structure; hard when dry, very friable when moist and slightly sticky non-plastic when wet; few macropores and mesopores; clear wavy boundary.
C	55–78 cm	white (2.5Y 8/2) loam, white (2.5Y 8/0) when dry; weak fine subangular blocky; hard when dry, very friable when moist and slightly sticky and non-plastic when wet; few macropores and mesopores; gravel and stones; clear smooth boundary
R	> 78 cm	limestone.

This profile has an ochric epipedon and a calcic horizon.

Profile 9.
Profil 9.

ThA Angular-cobbly locally very shallow clayey Undulating Terrace Soils over limestone

Great Konya Basin, Karaman Area, 19.6 N, 98.3 E, alt. about 1060 m, 7–9–1966 (van der Pouw

Geomorphology: dissected terrace, moderately eroded
Parent material: calcareous clay-loam
Relief and slope: normal to excessive, rolling
Stoniness: Class 2
Hydrology: excessively drained, watertable below 10 m
Moistness: dry
Salinity: saltfree

Biology: Until 23 cm fine, medium and large roots common, common biopores, undisturbed subsoil below
Land-use: dry-farming, fallow
Classification:
1964 Lithic Haplorthent
1967 Lithic Xerorthent

Soil description of Profile 9

Ap11	0– 3 cm	brown (7.5YR 4.5/4) clay-loam, 7.5YR 6/4 when dry; cherty and coarse cherty; moderately weak thin platy structure; soft; very friable; slightly plastic and slightly sticky; common mesopores and macropores; abrupt smooth boundary
Ap12	3–10 cm	brown (7.5YR 4.5/4) clay-loam, 7.5YR 6/4 when dry; cherty and coarse cherty; moderately weak fine medium granular structure; slightly hard; very friable; slightly plastic and slightly sticky; common mesopores and macropores; abrupt smooth boundary.
Ap2	10–12 cm	brown (7.5YR 4.5/4) loam to clay-loam, 7.5YR 6/4 when dry; cherty and coarse cherty; weak fine medium platy and locally moderately weak fine medium granular structure; slightly hard; very friable; slightly plastic and sticky; few to common mesopores and macropores; abrupt smooth boundary.
A1	12–23 cm	brown (7.5YR 4.5/4) loam, 7.5YR 6/4 when dry; cherty and coarse cherty; very weak very coarse granular structure breaking down to a moderately weak fine medium granular structure; slightly hard; very friable; slightly plastic and sticky; common mesopores and macropores; abrupt smooth boundary.
R	> 23 cm	white limestone.

This profile has an ochric epipedon and a lithic contact.

Tc Soft Lime Soils The lowest visible level of the Neogene structural terraces has been flooded by the Pleistocene Lake Konya. The surface was abraded flat and covered with a sediment of almost pure soft lime, formed both by decomposition of limestone and by precipitation from water seeping out from the karstic limestones. Near the watertable carbonates are redistributed into hard concretions and pans.

Soft Lime Soils occur in the Konya Area near Kaşınhanı, in the Çumra Area near Ürünlü both at 1005 m and in the Ereğli and Bor areas at 1020–1050 m. Ancient Lake Konya has never flooded those higher parts and there is no solid Neogene limestone in the subsoil. However, the soft lime deposits there so closely resemble the upper part of those in the west of the Basin that they have been included in the association. Their genesis might be the entire result of lateral carbonate enrichment, 'lime salinization'.

The surface brown loam above the soft lime is characteristic and seems not to be derived from it but rather to have been transported by wind or water from the Alluvial Fans or Bajadas. Small parts have dark-gray organic surface soil which seems residual. Such areas are marshy with a vegetation of rush (*Juncus maritimus*).

TcA Locally very shallow loamy or clayey over soft lime, (Fig. 26, Profiles 10 and 11 and Table 4) consist of white usually angular-blocky or prismatic porous soft lime with hard pellets or concretions near the watertable over Neogene limestone at 100 to 500

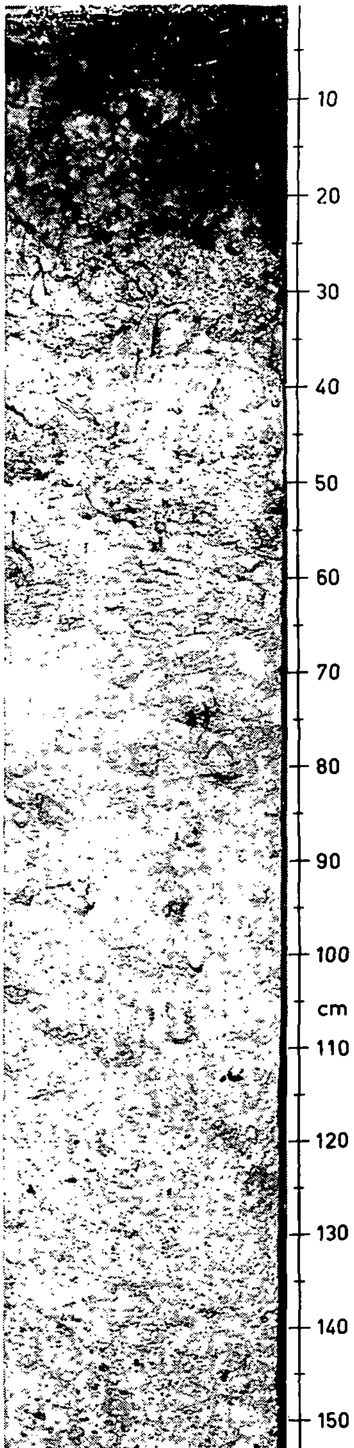


Fig. 26. Profile no 10.
Şekil 26. Profil no. 10.

TcA *Sometimes very shallow loamy or clayey over soft lime*

Great Konya Basin, Çumra Area, 67.1 N, 88.2 E, alt. about 1005 m, 23–8–1964 (van Blom)

Geomorphology: soft lime plain
Parent material: soft lime
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: imperfectly drained, watertable 160 cm
Moistness: dry
Salinity: slightly salt-affected
Biology: many roots until 10 cm, few roots from 10 to 97 cm
Land-use: grazing
Classification: 1964 Aquic Haplorthent
1967 Aquic Xerorthent

Table 4. Analytical data of Profile 10.

Horizon	Depth (cm)	Particle-size distribution						$CaCO_3$ eq. (%)
		<2μm		2–50μm		> 50μm		
		$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	
A12	10–20	44.5	26.0	32.7	45.7	22.8	28.3	54.5
C1	60–70	50.7	23.4	32.7	56.1	26.6	20.5	80.5

Depth	pH	ECe	CEC	ESP
0– 10	7.70	0.98	18.35	20.16
10– 20	8.10	1.65	–	–
20– 30	8.62	2.91	–	–
30– 40	8.85	3.79	–	–
40– 50	8.88	4.46	15.3	35.1
50– 60	8.84	4.44	–	–
60– 70	8.59	2.87	–	–
70– 80	8.38	1.91	–	–
80– 90	7.95	0.86	10.7	25.9
90–100	7.81	0.69	–	–
100–110	7.74	0.52	–	–
110–120	7.71	0.51	–	–

Tablo 4. Profil 10'a ait analitik bilgiler.

Soil description of Profile 10.

A11 0– 6 cm grayish-brown (10YR 4.5/3) loam, pale-brown (10YR 6.5/3) when dry; weak thin platy; sticky, slightly plastic when wet, very friable when moist, soft when dry; few macropores, few mesopores; abrupt smooth boundary.

A12 6– 24 cm grayish-brown (10YR 4.5/3), loam, very pale-brown (10YR 7/3) when dry; weak coarse subangular-blocky; sticky slightly plastic when wet, friable when moist, slightly hard when dry; few macropores and mesopores; clear wavy boundary.

AC 24– 46 cm very pale-brown (10YR 7/2) clay-loam, white (10YR 8/2) when dry; weak medium angular-blocky; very sticky, slightly plastic when wet, very friable when moist, slightly hard when dry; few lime concretions; few macropores and mesopores; abrupt wavy boundary.

C1 46– 97 cm white (10YR 8/2) clay loam (soft lime), white (10YR 8/1) when dry; moderate medium angular-blocky; partly platy; very sticky, slightly plastic when wet, very friable when moist, hard when dry; few macropores and mesopores; few lime concretions; clear wavy boundary.

C2 97–105 cm white (5Y 8/1) clay-loam (soft lime), structureless and massive; very sticky, slightly plastic when wet, very friable when moist, very hard when dry; common medium faint rust mottles; common medium lime concretions surrounded by rust mottles; clear wavy boundary.

C3 105–128 cm similar but common lime concretions and rust mottles.

C4 128–140 cm similar but few coarse lime concretions and rust mottles.

This profile has an ochric epipedon.

Profile 11.
Profil 11.

TcA Locally very shallow loamy or clayey Soft Lime Soils over soft lime

Great Konya Basin, Ereğli Area, 79.8 N, 210.8 E, alt. about 1047 m, 15–8–1967, (Ruessink)

Geomorphology: soft lime plain
Parent material: clastic calcium carbonate and dolomite
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: moderately well drained, watertable about 1 m
Moistness: dry down to 40 cm, moist from 40 to 100 cm
Salinity: externally strongly salt-affected
Biology: common medium and fine roots down to 40 cm, common biopores in surface soil
Land-use: ranging
Classification: 1967 Salorthidic Xerorthent

Soil description of Profile 11.

A1	0–37 cm	grayish-brown to light-grayish-brown (10YR 5.5/2) loam, dark-grayish-brown to brown (10YR 4.5/2) when moist with a strong coarse angular-blocky structure; very hard when dry; mesopores and macropores; clear smooth boundary.
B2	37–80 cm	light-brownish-gray to light-gray (10YR 6.5/2) soft lime with a moderate medium angular-blocky structure; friable; many mesopores and macropores; remnants of old roots; clear wavy boundary.
Csa	> 80 cm	light-brownish-gray to light-gray (10YR 6.5/2) soft lime; very friable; common mesopores and macropores; structureless; many lime concretions near watertable.

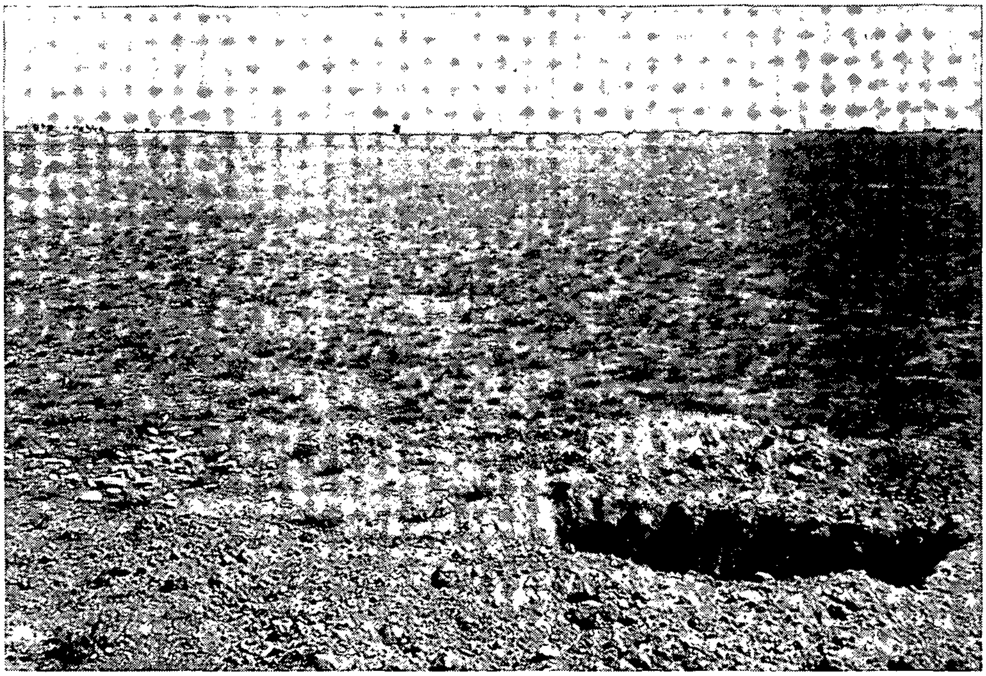
This profile has an ochric epipedon, a salic horizon and a cambic horizon.

cm except in the Ereğli and Bor areas. They are moderately well drained but salt-affected. The relief is flat. Locally patches or knolls of bedrock (TcC) occur. The unit is used mainly for grazing but the less saline areas near Ürünlü are dry-farmed if the surface soil is moderately deep. Roots penetrate only the loamy surface soil so that its depth governs soil suitability. The soft lime is quarried for building.

TcB Locally very shallow loamy or clayey over concreted soft lime are like TcA except that the white soft lime subsoil contains many concretions, locally cemented into a hardpan, and occur at a slightly lower level. They are poorly drained, but are saltfree or only slightly affected because of abundant seepage of fresh water from the nearby Uplands. They are used for grazing.

TcC Locally very shallow loamy or clayey over limestone (Fig. 27) are like other units of Soft Lime Soils but the locally very shallow brown loam rests directly on Neogene limestone which sometimes outcrops. They are flat and occur in small patches, north-west of Fethiye and near Ürünlü (Çumra Area). They are covered with short grass and are used for ranging, which is very poor.

Fig. 27. Landscape near Ürünlü, Çumra Area. Very shallow surface soil (see pit) over limestone in shallow patch of TeC. Landuse is poor ranging (suitability class IVa).



Şekil 27 Çumra bölgesinde Ürünlü yakınlarında bir manzara. TeC'nin sığ kısımlarında kireç taşı üzerinde çok sığ yüzey toprağı. Arazi kullanması zayıftır (Elverişlilik sınıfı IVa).

Tg Terrace Gully Soils South of Çumra and south-west of Kaşınhanı (Çumra Area) and elsewhere in the Basin are wide steep-sided U-shaped gullies whose bottoms are flat and filled with debris. They presumably originated in the Pleistocene and now act as channels for run-off from the Terraces they traverse. South-west of Kaşınhanı they have clearly been the channels through which Bajada material was transported. South of Çumra they end abruptly and little of the material they once transported can be detected. The rocky gully sides have been included in the association.

TgA Shallow clayey over limestone, including rocky slopes are complex, varying in depth and stoniness. They are rarely cultivated and are mainly used for ranging.

5.5 B Bajadas (Fig. 28)

Bajadas as defined by Thornbury (1965) consist of sediments which have been transported a short distance through many erosion gullies from the Uplands into the Basin. Locally they form an elongated plain of ill-sorted loams or clays parallel to the Basin's border. They slope gently towards the centre of the Basin. The upper portion nearest the Uplands consists of a number of small coalescing fans and merges into Colluvial Slopes. Whether this zone is mapped as Colluvium or as Bajada depends on its width and slope. For details see de Meester & van Schuylenborgh (1966), and in Part B of this report.

Bajadas merge into Alluvial Plain if they are deposited by a few big gullies only and if stratification is apparent. The Bajadas are divided into two soil associations according to the origin of the transported material.

The Bajadas consist of 2 associations and 7 units.

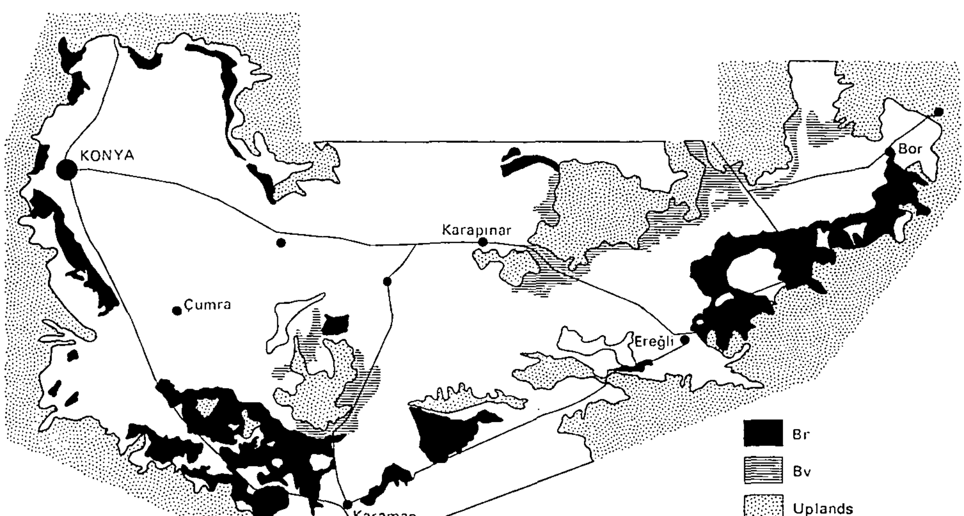
Br Limestone Bajada Soils

- BrA Predominantly reddish-brown clayey
- BrB Predominantly brown loamy or clayey
- BrC Sloping eroded gravelly loamy or clayey
- BrB Dissected gravelly clayey

Bv Volcanic Bajada Soils

- BvA Locally vertic clayey
- BvB Gravelly sandy or loamy, locally with duripan
- BvC Sloping angular-cobbly sandy or loamy

Fig. 28. Distribution of Volcanic (Bv) and Limestone (Br) Bajada Soils.



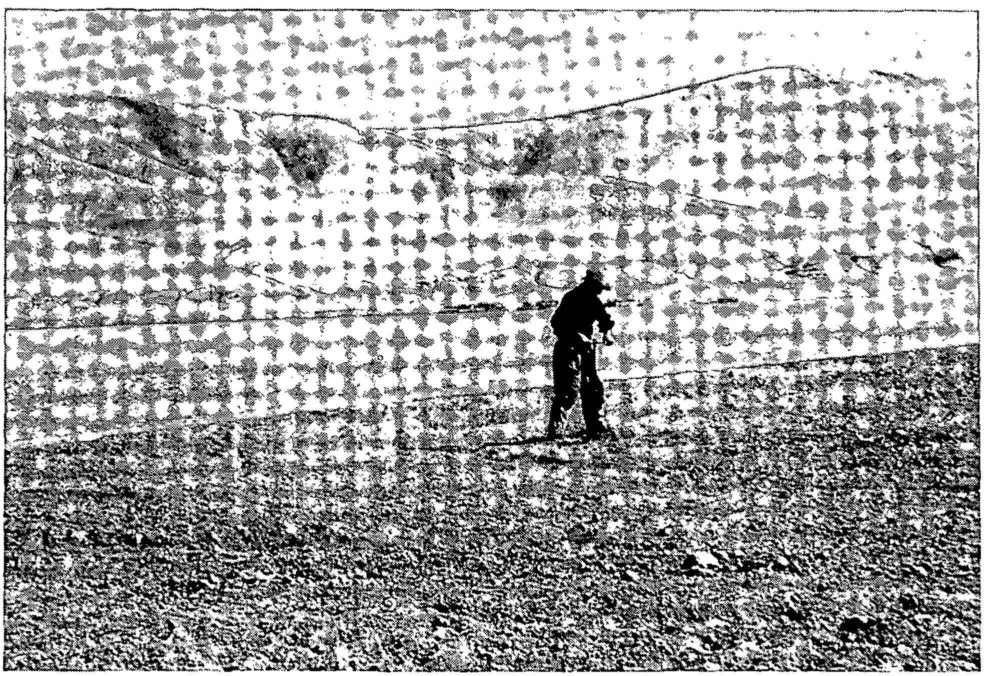
Şekil 28. Volkanik (Bv) ve kireçtaşı (Br) Bajada Toprakları'nın dağılımı.

Br Limestone Bajada Soils Limestone Bajada Soils consist of weathering products of limestone. Hard limestone generally produces reddish soil, soft limestone brown soil. In the Basin, Bajadas at the foot of Cretaceous limestone are reddish (5–7.5YR), and those near Neogene limestone are brown (10YR). Data about hardness of each type of limestone are not available.

BrA Predominantly reddish-brown clayey (Figs. 29 and 30, Profiles 12 and 13 and Table 5) are deep reddish-brown (5YR 4/4) to yellowish-red (5YR 4/8) loams or clays with a subangular-blocky surface soil and an angular-blocky subsoil. Small slickensides are common below 100 cm. A calcic horizon is common and consists of clearly visible white hard and soft secundary lime segregations of various shapes and sizes. The B horizon has pressure coatings.

They are well drained and saltfree. Although not clearly stratified, there are obvious discontinuities such as old buried surface horizons, They are almost uniform as described, but vary in texture and thickness, and depth of calcic horizon with the terrain. Clays with less lime seggregation are found in the depressions, as near Illisira (Karaman Area).

Fig. 29. Limestone Bajada Soils near Çarıklar (Konya Area) (BrA). In background are the denuded Limestone Uplands, Limestone Colluvium (Cr) and the erosion gullies through which the bajada material was transported.



Şekil 29. Çarıklar yakınlarında (Konya bölgesi) (BrA) Kireçtaşı Bajada Toprakları. Arka plânda aşındırılmış kireç taşı yüksek arazileri, kireçtaşı koluvisyum'u (Cr) ve bajada materyallerinin içinden taşındığı erozyon galileri.

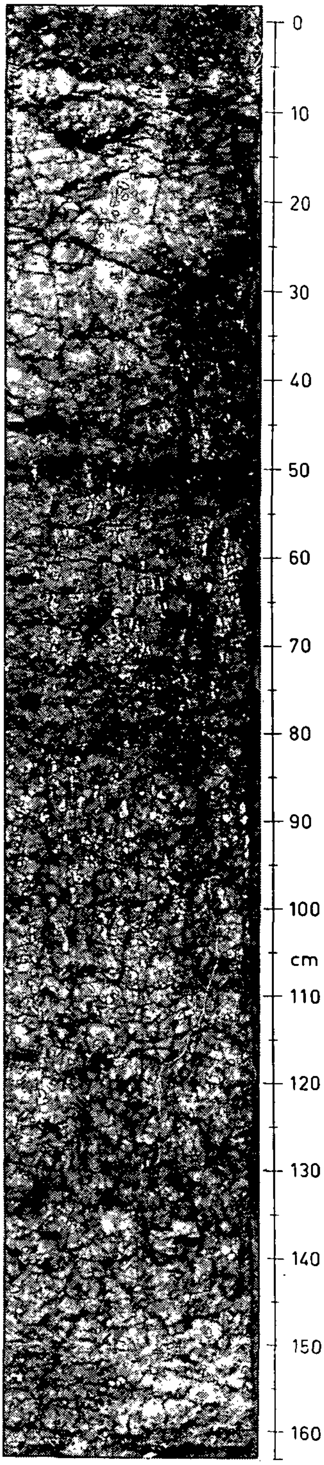


Fig. 29. Profile no 12.
Şekil 29. Profil no. 12.

BrA Predominantly reddish-brown clayey Limestone Bajada Soils

Great Konya Basin, Konya Area, 66.4 N, 63.4 E, alt. 1016–1017 m, August 1965 (de Meester)

Geomorphology: bajada
Parent material: clay with very fine limestone gravel
Relief and slope: level, gently undulating
Stoniness: Class 0
Hydrology: well drained, watertable about 9 m
Moistness: surface soil dry, subsoil moist
Salinity: saltfree
Biology: little activity
Land-use: dry-farming, fallow
Classification: 1964 Thapto Vertic Mollic Haplargid
1967 Thapto Vertic Haplic Haplargid

Soil description of Profile 12.

Ap1	0– 15 cm	reddish-brown (5YR 4/4) clay-loam, reddish-brown (5YR 5/4) when dry; ploughed horizon with mixture of loose medium and fine subangular clods; slightly sticky and plastic when wet, friable when moist and very hard to hard when dry; common mesopores and macropores; common calcareous fine gravel; abrupt smooth boundary.
Ap2	15– 30 cm	alike in colour; strong very thick and thick platy structure; common to much calcareous fine gravel; few mesopores and common macropores; abrupt smooth boundary.
B2tca	30– 52 cm	dark-reddish-brown (5YR 3.5/4) clay-loam to clay, reddish-brown (5YR 4/4) when dry; moderate coarse subangular-blocky structure; consistency like Ap1; few mesopores, common macropores; few pseudomycelia and few vertical lime bands, common calcareous fine concretions; discontinuous clay coatings; many small roots; gradual smooth boundary.
IIA1cab	52– 69 cm	reddish-brown (5YR 4/4) clay, reddish-brown (5YR 4.5/4) when dry; moderate medium subangular-blocky; consistency like Ap1; few mesopores, common macropores; no pseudomycelia; many discontinuous clay coatings; common vertical calcareous bands and calcareous powdery pockets with fine to medium concretions; few small horizontal roots; diffuse smooth boundary.
IIB2tcab	69– 93 cm	yellowish-red (5YR 4.5/6) clay, reddish-brown to light-reddish-brown (5YR 5.5/4) when dry; moderate medium angular-blocky; consistency like Ap1; few mesopores and macropores; common to many vertical calcareous bands with fine to medium concretions; few medium vertical clay pipes and many continuous coatings; clear wavy boundary.
IIB3cab	93–130 cm	reddish-brown to yellowish-red (5YR 4/5) silty clay, reddish-brown to light-reddish-brown (5YR 5.5/4) when dry; compound weak to moderate fine prismatic and moderate medium angular-blocky structure with few small well-developed slickensides; common medium clay pipes, many coatings, discontinuous and continuous clay coatings on the faces of prismatic and blocky peds; consistency like Ap1; very few lime mottles; clear smooth boundary.
IIICca	130–170 cm	silty-clay, alike in colour, strong to moderate wedge-shaped parallelepipedal elements (6 × 3 cm), well developed medium slickensides; consistency like Ap1; few fine gypsum veins; few krotovinas (diam. 6 cm) filled with crumb porous material and many small roots; little lime segregation.

This profile has an ochric epipedon, an argillic horizon and two calcic horizons.

Profile 13.
Profil 13.

BrA Predominantly reddish-brown clayey Limestone Bajada Soils

Great Konya Basin, Karaman Area, 27.8 N, 97.2 E, alt. about 1035 m, 24–5–1967 (Ruessink)

Geomorphology: bajada
Parent material: calcareous clay-loam
Relief and slope: subnormal, nearly level
Stoniness: Class 0
Hydrology: well drained, watertable below 10 m

Table 5. Analytical data of Profile 12.

Horizon	Depth (cm)	Particle-size distribution ($-CaCO_3$)			pH		$CaCO_3$ eq. (%)	org. C (%)
		< 2μm	2–50μm	> 50μm	H_2O	0.01 M $CaCl_2$		
Ap1	0– 15	51.2	31.8	17.0	8.00	7.50	12.1	0.84
Ap2	15– 30	58.1	23.5	18.4	8.16	7.52	13.6	0.52
B2tca	30– 52	61.2	24.7	14.1	8.29	7.55	18.3	0.43
IIA1cab	52– 69	53.7	33.8	12.5	8.32	7.61	12.8	0.62
IIB2tcab	69– 93	61.5	27.0	11.5	8.35	7.75	21.0	0.30
IIB3cab	93–130	54.9	33.1	12.0	7.70	7.60	23.6	0.23
IICcab	130–170	56.8	30.5	12.7	7.78	7.70	23.8	0.21

Depth (cm)		SiO_2 %	Fe_2O_3 %	Al_2O_3 %	TiO_2 %	MnO %	CaO %	MgO %	free Fe %	SiO_2/R_2O_3	SiO_2/Al_2O_3	SiO_2/Fe_2O_3	Al_2O_3/Fe_2O_3
0– 15	soil	52.5	6.60	15.2	0.71	0.20	8.4	2.84	1.83	4.60	5.87	21.2	3.61
	clay	50.6	9.08	20.6	0.86	0.06	—	—	—	3.26	4.18	14.9	3.56
15– 30	soil	51.8	6.34	15.0	0.69	0.18	8.3	2.94	1.77	4.62	5.86	21.8	3.72
	clay	49.3	9.03	20.6	0.80	0.06	—	—	—	3.18	4.06	14.6	3.59
30– 52	soil	49.2	5.99	14.7	0.66	0.17	10.7	2.95	1.78	4.52	5.69	21.9	3.85
	clay	50.5	9.02	20.4	0.84	0.06	—	—	—	3.28	4.21	14.9	3.54
52– 69	soil	51.8	6.34	15.2	0.67	0.19	9.1	2.93	1.86	4.59	5.81	21.8	3.75
	clay	52.5	8.85	19.6	0.83	0.06	—	—	—	3.53	4.54	15.8	3.48
69– 93	soil	46.8	5.74	14.2	0.62	0.15	12.8	2.99	1.68	4.44	5.59	21.7	3.88
	clay	51.4	9.01	19.7	0.81	0.06	—	—	—	3.43	4.43	15.2	3.43
93–130	soil	45.0	5.41	12.2	0.58	0.16	12.9	2.91	1.36	4.88	6.26	22.2	3.54
	clay	52.6	9.23	21.2	0.78	0.06	—	—	—	3.30	4.22	15.2	3.60
130–170	soil	44.6	5.19	11.8	0.55	0.15	13.0	2.95	1.25	5.01	6.41	22.9	3.57
	clay	50.0	8.63	19.8	0.76	0.05	—	—	—	3.36	4.30	15.5	3.60

Tablo 5. Profil 12'ye ait analitik bilgiler.

Moistness: moist to 120 cm, dry below 120 cm
Salinity: saltfree
Biology: medium and fine roots common down to 120 cm
Land-use: dry-farming, wheat
Classification: 1964 (Vertic) Haplorthent
1967 (Vertic) Xerorthent

Soil description of Profile 13.

Ap	0– 30 cm	yellowish-red (5YR 4/6) clay-loam; moderate medium subangular-blocky; friable; common mesopores and macropores; clear smooth boundary.
B21	30– 80 cm	reddish-brown (7.5YR 4/4) clay-loam; moderate medium angular-blocky; firm; common mesopores and macropores; discontinuous pressure coatings; pseudo-mycelia; gradual smooth boundary.
B22	80–120 cm	reddish-brown (7.5YR 4/4) clay-loam; moderate medium angular-blocky; firm; common mesopores and macropores; white powdery distinct common and medium calcareous pockets; abrupt smooth boundary.
R	> 120 cm	limestone.

This profile has an ochric epipedon and a cambic horizon

Profile 14.
Profil 14.

BrB Predominantly brown loamy or clayey Limestone Bajada Soils

Great Konya Basin, Karaman Area, 30.5 N, 142.7 E, alt. about 1020 m, 2–9–1966 (de Wit)

Geomorphology: bajada
Parent material: calcareous clay-loam or silt-loam
Relief and slope: flat or concave, level
Stoniness: Class 0
Hydrology: somewhat excessively drained, watertable about 10 m
Moistness: dry to 115 cm, slightly moist 115–165 cm
Salinity: saltfree
Biology: few krotovinas, few large wormholes, roots down to 110 cm
Land-use: dry-farming, wheat
Classification: 1964 Typic Calciorthid
1967 Typic Calciorthid

Soil description of Profile 14.

Ap	0– 18 cm	dark-yellowish-brown (10YR 4/4) clay-loam, light-yellowish-brown (10YR 6/4) when dry; weak very coarse angular-blocky clods, subdivided into weak moderate medium and coarse subangular-blocky elements; soft to slightly hard when dry, very friable when moist, sticky and slightly plastic when wet; common mesopores and many macropores; few large and very large biopores, some with faecal pellets; common fine, few medium and large roots; little fine white and dark gravel; abrupt smooth boundary.
B2ca	18– 45 cm	brown to strong brown (7.5YR 5/5) clay-loam, light-brown (7.5YR 6/4) when

dry; strong fine and medium angular-blocky; very hard when dry, very friable when moist, sticky and slightly plastic when wet; few mesopores and macropores; few large and very large biopores, some with faecal pellets; common distinct fine and medium white lime concretions, slightly hard when dry, loose when moist; few to common clay pipes with rounded surfaces in old biopores; few very fine dark and fine white gravel; clear to gradual smooth boundary.

Cca 45– 90 cm light-brown (7.5YR 6/5) silt-loam, very pale-brown (10YR 7/4) when moist; soft when dry, loose when moist; slightly sticky and slightly plastic when wet; many mesopores and common macropores; common medium and coarse distinct white lime concretions, soft to slightly hard when dry; few krotovinas, filled with very fine crumb soil and gravel; clear irregular boundary.

C21 90–110 cm as above but many fine and medium white calcareous and common fine dark-green serpentine gravel; clear irregular boundary.

C22 110–165 cm light-brown to reddish-yellow (7.5YR 6/5) silt-loam, very pale-brown to yellow (10YR 7/5) when dry; hard when dry, very friable when moist; slightly sticky and slightly plastic when wet; many mesopores, common macropores; common very fine dark minerals; bounded by a second gravelly layer.

This profile has an ochric epipedon, a cambic and a calcic horizon.

Profile 15.
Profil 15.

BrB Predominantly brown loamy or clayey Limestone Bajada Soils

Great Konya Basin, Ereğli Area, 64.7 N, 199.3 E, alt. about 1027 m, 21–9–1966 (van Beek)

Geomorphology: bajada
Parent material: calcareous fine gravelly clay-loam to loam
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: well drained, watertable deeper than 10 m
Moistness: dry throughout the profile
Salinity: saltfree
Biology: slightly disturbed between 150 and 200 cm, deeper undisturbed; very large and large biopores common throughout the profile, fine roots common to 125 cm
Land-use: dry-farming
Classification: 1964 Typic Camborthid
1967 Typic Camborthid

Soil description of Profile 15.

Ap 0– 15 cm dark-brown (7.5YR 4/4) fine-gravelly clay-loam loose clods of different size; slightly sticky and slightly plastic, very friable, slightly hard; common macropores; clear smooth boundary.

B2 15– 45 cm dark-brown (7.5YR 4/4) fine-gravelly clay-loam; moderate medium to coarse subangular; slightly sticky and slightly plastic, very friable, slightly hard; many macropores and common mesopores; clay coatings; gradual smooth boundary.

B3 45– 78 cm brown (7.5YR 4.5/4) fine-gravelly clay-loam; weak medium to coarse subangular; slightly sticky and slightly plastic, very friable, slightly hard; many

		macropores, common mesopores; clay coatings; few prominent very pale-brown (10YR 8/3) fine round calcareous mottles; gradual smooth boundary.
Cca	78–128 cm	yellowish-brown (10YR 5/4) fine-gravelly clay-loam; massive; slightly sticky and slightly plastic, very friable, slightly hard; many macropores, common mesopores; many prominent fine to medium very pale-brown (10YR 8/3) round calcareous mottles and soft powdery calcareous pockets, sometimes with a hard centre.
C2	128–203 cm	yellowish-brown (10YR 5/4) fine-gravelly loam; massive; slightly sticky and slightly plastic, very friable, slightly hard; many macropores, common mesopores; some small fine-gravelly layers.
C3	203–220 cm	fine-gravelly sand.

This profile has an ochric epipedon and a cambic horizon.

Where Bajadas cover Terraces, soft white lime occurs in the subsoil, Nearest to the Basin's centre Bajadas may fan out over soft limes (Tc).

They occur mainly in the west of the Çumra Area and the south-west of the Karaman Area. South of Bor are reddish-brown Bajadas.

Almost all are dry-farmed with wheat. Very small patches are irrigated, as west of Kaşınhanı (Çumra Area). They seem the best soils in the Basin.

BrB Predominantly brown loamy or clayey (Profiles 14 and 15) resemble BrA, but are brown (10YR) and often coarser textured and may be less prismatic. They lack slickensides. The profile is deep, well drained and saltfree. They are less uniform than BrA, varying between clay and sandy-loam. Stoniness increases towards the Uplands. They have normal relief and are gently sloping, except near the Uplands where the relief may be excessive. They cover many small patches, bordering Limestone Uplands as in the Konya Area. The south-west of the Karaman Area, mainly near Çanhasan, has brown (7.5YR 4.5/4) Bajada soils transitional in colour to BrA but coarser in texture. There is large BrB Bajada in the Ereğli Area, north of Bulgurluk, with dark-brown clay-loam to clay, mixed with some fine gravel. Part of the land is dry-farmed with wheat and rye, part is used for ranging.

BrC Sloping eroded gravelly loamy or clayey are deep loamy, locally gravelly to the surface, brown (10YR) or reddish-brown (5–7.5YR) with a weak calcic horizon or a zone with pseudomycelia. They range in texture, stoniness and depth, being a complex strip of coalescing fans. Sandy patches and areas paved with chert and gravel occur locally.

They merge into Colluvial Slopes where BrA or BrB approach the Uplands. They form a continuous strip of coalescing fans but are mapped only if wide enough. Otherwise they are included in either CrA or BrA and BrB.

A long strip occurs west of Ilisira (Karaman Area south-west) and north of the Karadağ Massif (Hotamış Area south). A third area is around the Erentepe (Karaman Area), an ultrabasic formation, and differs slightly from the others by being very complex and severely eroded radially from the hilltop.

Seepage from the nearby denuded Uplands keeps them moist and they are usually cultivated with wheat, rye or grapes. Productivity depends on the depth of the soil.

BrD Dissected gravelly clayey (Fig. 31, Profile 16) are deep gravelly yellowish-brown (10YR 5/4) loams of clay-loams with a well developed calcic horizon, locally even a petrocalcic one and often a gypsic horizon.

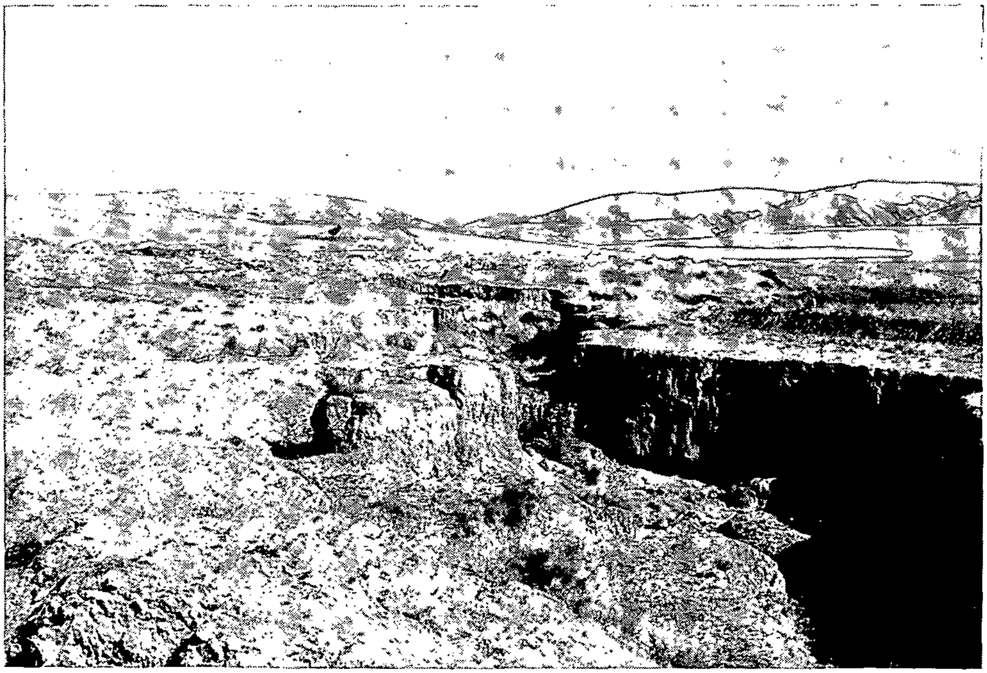
They occur on the lower slopes of a huge presumably Tertiary Bajada south of the Ereğli-Ulukisla road (Ereğli Area south). They are severely incised by gullies and streams and give rise to a secondary gravelly Bajada downhill (BrB) with little or no profile development. The terrain between the gullies is undulating. The soil is well drained and non-saline. They are complex, varying mainly in depth, relief and stoniness. Locally they are very shallow over pure gypsum (presumably a former volcanic deposit). Most of them are ranged but a few are under dry wheat.

Bv Volcanic Bajada Soils Like the Limestone Bajada Soils they verge on Uplands, in this case volcanic. Part of the material may have been deposited as ash after an eruption and has been very much reworked by rainwater.

In most places the volcanic material is mixed with limestone debris.

They occur around the Karadağ Massif (Karaman Area) and in the north of the Karapınar, Ereğli and Bor areas.

Fig. 31. Dissected gravelly clayey Bajada Soils (BrD). A deeply incised gully, east of Ereğli, Ereğli Area. Hills in background are Tertiary bajadas also consisting of gravelly clay.



Şekil 31. Yarılmış çakıllı killi Bajada Toprakları (BrD). Ereğli bölgesinde, Ereğlinin doğusunda derince aşındırılmış galiler. Arka plândaki tepeler çakıllı kil tarafından meydana gelen Tersiyer bajadalardır.

Fig. 32. Profile of a gravelly Volcanic Bajada Soil (BvB) with duripan. In background are a canal dike and the summit of a volcanic cone (Ereğli Area north).

Şekil 32. Duripen'li çakıllı Volkanik Bajada Toprağına ait bir profil.

BvA Locally vertic Clayey (Profiles 17 and 18) are deep and very deep dark-brown (10YR 3/3, locally 10YR 3.5/3.5) volcanic clays with at most a weakly developed calcic horizon and an angular-blocky or prismatic structure. At the lowest spots are vertic features (slickensides and wide cracks). Lime nodules may occur in the subsoil. They are poorly drained and moderately salt-affected (internal solonchacks). They are flat and nearly level. In the three areas of Volcanic Bajada Soils, they foot onto large Bajadas and might be considered as Bajada basin deposits. Heavy-clay with vertic features occurs near Mandosun (Karaman Area). A strip with a thin surface layer of sand and without vertic features occurs north-east of Kilbasan (Karaman Area north) over lacustrine marls. In Ereğli Area north there are yellowish-brown to brownish-yellow (10YR 5/6) loams to clay-loams with lime nodules and spots and locally a hard crust. They are under dry wheat except north of Kilbasan which is used for ranging.

BvB Gravelly sandy or loamy, locally with duripan (Fig. 32 Profile 19) are deep, brown (10YR 4/3) or dark-yellowish-brown (10YR 3/4) calcareous sands to loams mixed with volcanic ash and pumice, locally gravelly or cobbly, with locally hard platy surface soil, a structural B horizon, at most a locally weak horizon of pseudomycelium, locally a duripan at 100–120 cm and layers of weakly cemented sand. They are normal to nearly level, locally with sheet and gully erosion.

They are well drained and saltfree. The unit is fairly uniform except for local changes in texture, stoniness and occurrence of a duripan. Higher parts are transitional to BvC. They ocçur in Karapınar Area north-east and Ereğli Area north.

They are mainly ranged. Near Karapınar, Türkmen (nomads) harvest camelthorn (*Alhagi camelorum*) as winter fodder for their camels (See Fig. 20).

BvC Sloping angular-cobbly sandy or loamy (Profile 20) are transitional between Volcanic Colluvial Soils and BvB, commonly with a duripan. They are stonier and steeper than other Volcanic Bajada Soils. They are complex, usually including a narrow strip of CvA in the upper part and a strip of BvB in the lower. If deposited by a single gully, they are mapped as Soils of Medium-Sized Fans (AuC). They are under dry wheat.

Profile 16.
Profil 16.

BrD Dissected gravelly clayey Limestone Bajada Soils

Great Konya Basin, Ereğli Area, 72.0 N, 212.4 E, alt. about 1055 m, 16–9–1966 (van den Eelaart)

Geomorphology: bajada
Parent material: calcareous gravelly sandy loam
Relief and slope: normal, sloping
Stoniness: Class 0
Hydrology: well drained, watertable deeper than 10 m
Moistness: slightly moist below 20 cm, surface dry
Salinity: saltfree
Biology: roots and biopores common to 100 cm
Land-use: dry-farming, wheat
Classification: 1964 Typic Calciorthid
1967 Typic Calciorthid

Soil description of Profile 16.

Ap1	0– 12 cm	yellowish-brown (10YR 5/6) gravelly loamy-sand, yellow (10YR 7/6) when dry; small clods; soft when dry, very friable when moist, non-plastic and non-sticky when wet; many mesopores and macropores, few biopores; roots common; abrupt smooth boundary.
Ap2	12– 20 cm	light-yellowish-brown (10YR 6/4) gravelly sandy-loam; massive structure; hard when dry, friable when moist, non-plastic and non-sticky when wet; common mesopores and macropores; clear smooth boundary.

B1 20– 50 cm light-yellowish-brown (10YR 6/4) gravelly sandy-loam; massive to moderate fine subangular-blocky structure; soft when dry, very friable when moist, non-plastic and non-sticky when wet; many mesopores, common macropores; gradual smooth boundary.

B2ca 50–100 cm very pale-brown (10YR 7/4) gravelly loam; massive to moderate fine subangular-blocky structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; few mesopores, common macropores; many distinct medium soft calcareous spots; gradual smooth boundary.

C1 100–135 cm light-yellowish-brown (10YR 6/4) gravelly fine loamy-sand; massive structure; soft when dry, very friable when moist, non-plastic and non-sticky when wet; many mesopores, many macropores, few roots.

This profile has an ochric epipedon and a calcic horizon.

Profile 17.
Profil 17.

BvA Locally vertic clayey Volcanic Bajada Soils

Great Konya Basin, Karaman Area, 34.2 N, 101.7 E, alt. about 1016 m, 8–9–1966 (van der Pouw)

Geomorphology: bajada
Parent material: volcanic calcareous clay
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: well drained, watertable deeper than 10 m
Moistness: 0–50 cm dry, 50–100 cm almost dry, deeper than 100 cm slightly moist
Salinity: saltfree
Biology: few fine roots to 125 cm; few large biopores to 180 cm
Land-use: dry-farming, fallow
Classification: 1964 Typic Grumustert
1967 Typic Chromoxerert

Soil description of Profile 17.

Ap1 0– 19 cm dark-brown to dark-yellowish-brown (10YR 3.5/3.5) clay, 10YR 5/3 when dry; moderately strong fine medium and coarse subangular-blocky and a moderately strong very fine and fine granular structure; hard; friable; plastic and sticky; common mesopores and macropores; abrupt smooth boundary.

Ap2 19– 24 cm dark-brown to dark-yellowish-brown (10YR 3.5/3.5) clay, 10YR 5/3 when dry; moderately strong very thick platy structure; hard; friable; plastic and sticky; common mesopores and macropores; abrupt smooth boundary.

B1 24– 49 cm dark-brown to dark-yellowish-brown (10YR 3.5/3.5) clay, 10YR 5/3 when dry; moderately strong very coarse prismatic and angular-blocky structure breaking to a moderately weak very thick platy structure; hard; friable; plastic and sticky; few to common mesopores and macropores; common coarse distinct slickensides; clear smooth boundary.

B21 49–107 cm dark-brown to dark-yellowish-brown (10YR 3.5/3.5) clay, 10YR 5/3 when dry; moderately strong coarse and very coarse prismatic structure breaking to a moderately strong medium and coarse structure commonly wedge-shaped;

very hard; firm; plastic and sticky; few to common mesopores and macropores; many coarse prominent slickensides; few to common medium prominent white hard calcareous concretions; clear smooth boundary.

B22 107–125 cm yellowish-brown (10YR 5/4) clay, 10YR 6/4 when dry; with a strong coarse and very coarse angular-blocky structure; hard; firm, plastic and sticky; common mesopores and macropores; common coarse distinct slickensides; few to common fine prominent white hard calcareous concretions; abrupt smooth boundary.

IIC 125–180 cm light-gray (10YR 7/2) sandy-clay-loam, 10YR 8/2 when dry; massive; hard; very friable; slightly plastic and slightly sticky; common mesopores and macropores; common krotovinas.

This profile has an ochric epipedon, a cambic horizon and slickensides and deep cracks.

Profile 18.
Profil 18.

BvA Locally vertic clayey Volcanic Bajada Soils

Great Konya Basin, Ereğli Area, 86.6 N, 190.0 E, alt. about 1080 m, 17–9–1966 (van den Eelaart)

Geomorphology: bajada
Parent material: volcanic calcareous loam
Relief and slope: normal, nearly level
Stoniness: Class 0
Hydrology: well drained, watertable deeper than 10 m
Moistness: slightly moist, except top 15 cm
Salinity: saltfree
Biology: biopores and roots throughout the profile
Land-use: dry-farming, wheat and rye
Classification: 1964 Typic Calciorthid
1967 Typic Calciorthid

Soil description of Profile 18.

Ap 0– 15 cm yellowish-brown to brownish-yellow (10YR 5.5/6) loam, very pale-brown when dry (10YR 7/4); many coarse clods; slightly hard when dry, friable when moist, slightly plastic and slightly sticky when wet; common mesopores and common macropores; clear smooth boundary.

B1 15– 50 cm yellowish-brown to brownish-yellow (10YR 5.5/6) loam; moderate medium subangular-blocky structure; soft when dry, friable when moist, plastic and sticky when wet; common mesopores and common macropores; clear smooth boundary.

B21 50– 65 cm yellowish-brown to brownish-yellow (10YR 5.5/6) loam to clay-loam; moderate medium subangular-blocky structure; soft when dry, friable when moist, plastic and sticky when wet; common mesopores, and common macropores; many concretions 2 cm diam.; clear smooth boundary.

B22ca 65– 95 cm yellow (10YR 7/6) loam; moderate subangular-blocky structure; soft when dry, friable when moist, plastic and sticky when wet; common mesopores and common macropores; many faint medium calcareous spots; clear smooth boundary.

B3ca 95–120 cm brownish-yellow (10YR 6/6) loam; moderate subangular-blocky structure; soft when dry, friable when moist, plastic and sticky when wet; common mesopores and common macropores; few faint medium calcareous spots.

This profile has an ochric epipedon and a calcic horizon.

Profile 19.
Profil 19.

BvB Gravelly sandy or loamy Volcanic Bajada Soils, locally with duripan

Great Konya Basin, Ereğli Area, 87.3 N, 198.3 E, alt. about 1080 m, 2–7–1966 (van den Eelaart)

Geomorphology: bajada
Parent material: volcanic, calcareous loamy sand
Relief and slope: normal, nearly level
Stoniness: Class 0
Hydrology: excessively drained, watertable deeper than 10 m
Moistness: slightly moist, top 15 cm almost dry
Salinity: saltfree
Biology: few biopores and many roots to 82 cm
Land-use: dry-farming, wheat or rye, yield about 1000 kg/ha.
Classification: 1964 Andic Durorthid
1967 Andic Durorthid

Soil description of Profile 19.

Ap1 0– 8 cm dark-grayish-brown (10YR 4/2) fine-gravelly loamy-sand, light-brownish-gray (10YR 6/2) when dry; weak thin platy structure; soft when dry, very friable when moist and non-plastic and non-sticky when wet; many mesopores and macropores, abrupt smooth boundary.

Ap2 8– 15 cm dark-grayish-brown (10YR 4/2) fine-gravelly loamy-sand; moderate very thick platy structure; slightly hard when dry, friable when moist and non-plastic and non-sticky when wet; common mesopores, few macropores; abrupt smooth boundary.

C2 15– 82 cm brown (10YR 4/3) fine-gravelly loamy-sand; massive structure; many mesopores, common macropores; abrupt smooth boundary.

C2si 82–102 cm yellowish-brown (10YR 5/4) fine-gravelly loamy-sand; massive structure; almost loose and very hard when dry, very friable and extremely firm when moist and non-sticky and non-plastic when wet; few mesopores and macropores; many nodules diam. 5 cm; abrupt smooth boundary

IIC1sim > 102 cm indurated volcanic sand and volcanic ash (duripan).

This profile has an ochric epipedon and a duripan.

Profile 20.
Profil 20.

BvC Sloping angular-cobbly sandy or loamy Volcanic Bajada Soils.

Great Konya Basin, Karaman Area, 35.7 N, 102.9 E, alt. about 1035 m, 8–9–1966 (van der Pouw)

Geomorphology: bajada
Parent material: volcanic calcareous sandy loam
Relief and slope: subnormal, gently sloping
Stoniness: Class 0
Hydrology: somewhat excessively drained, watertable below 10 m
Moistness: dry throughout the profile.
Salinity: saltfree
Biology: 0–60 cm common fine and medium roots; > 120 cm undisturbed subsoil; common biopores to 60 cm.
Land-use: dry-farming, wheat
Classification: 1964 Andic Calciorthid
1967 Andic Calciorthid

Soil description of Profile 20.

A1	0– 61 cm	dark-yellowish-brown (10YR 3/4) sandy-loam 10YR 5/3 when dry; gravelly and cobbly; moderately weak fine and medium crumb; soft; very friable; slightly plastic and non-sticky to slightly sticky; common mesopores and macropores; few krotovinas; abrupt smooth boundary.
C1ca	61–120 cm	dark-yellowish-brown (10YR 3/4) gravelly and cobbly loam to clay-loam 10YR 6/4 when dry; massive; weakly cemented; hard; very friable; slightly plastic and slightly sticky; few macropores and mesopores; many fine prominent pseudo-mycelia; abrupt smooth boundary.
C2ca	> 120 cm	indurated material (10YR 6/4 when dry).

This profile has an ochric epipedon, a cambic, a calcic and a petrocalcic horizon below one metre.

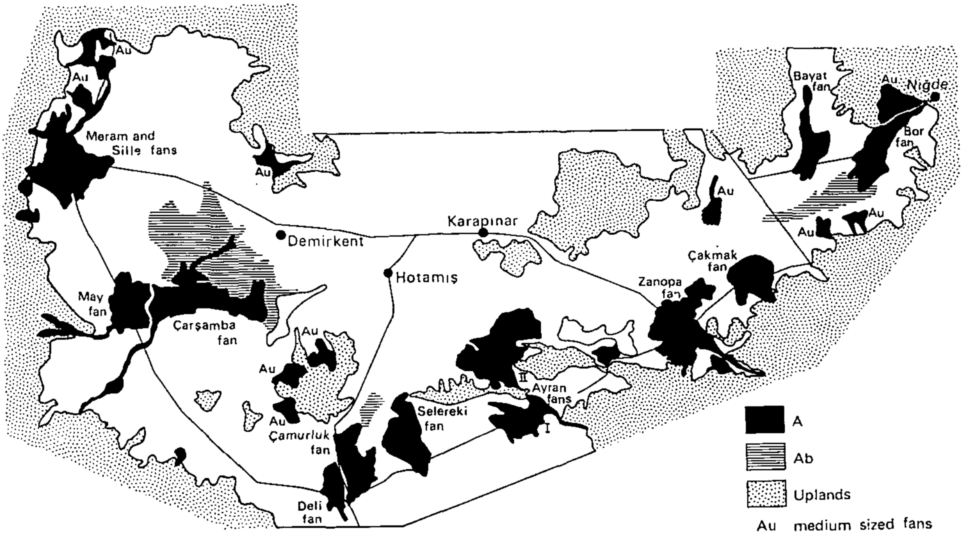
5.6 A **Alluvial Plains** (Fig. 33)

Rivers and streams from the Uplands have deposited fluvial soil material into the plain. Such deposits are called alluvial fans which in fact are true plains because of their size and flatness.

Their shape, size and soil depend on the size, climate and geology of the river's catchment area.

Some twelve rivers have formed large alluvial fans in the Basin and streams and gullies have formed many more small ones (Fig. 32). Sedimentation in the ever-changing river channels makes the soil pattern of an alluvial fan intricate both from place to place and between layers. The deposits of the River Çarşamba, the biggest river, form a delta rather than a fan. Some of its deposits are formed in swamps or marshes (Backswamps). Mapping units represent soil complexes, unless otherwise

Fig. 33. Distribution of Alluvial Plains (A) and their names, Backswamp Soils (Ab) and Medium-sized Fans.



Şekil 33. Alluviyal ovaların dağılışları (A) ve isimleri, Bataklıkardı Toprakları (Ab) ve orta büyüklükte yelpazeler.

stated. The descriptions of the various units can only be brief and general. They are in alphabetical order of unit symbols.

The Alluvial Plains consist of 13 associations and 32 units.

Aa Çamurluk Fan Soils

AaA Light-brown clayey

AaB Predominantly loamy

Ab Former Backswamp Soils

AbA Predominantly grayish swelling clayey

AbB Predominantly brownish swelling clay

AbC Mainly moderately shallow non-swelling clayey or loamy over soft lime or marl

AbD Dark-gray organic and carbonatic clayey

AbE Aeolian clayey (ridge)

Ac Çarşamba Fan Soils

AcA Clayey

AcB Loamy, locally sandy

AcC Loamy, over sandy subsoil

Ad Deli Fan Soils

AdA Clayey

AdB Loamy

Ae *Selereki Fan Soils*

AeA Locally shallow clayey over marl

AeB Loamy

Af *Çakmak Fan Soils*

AfA Clayey

AfB Loamy

Ag *Zanopa Fan Soils*

AgA Clayey

AgB Loamy or sandy

AgC Hydromorphic clayey

Ah *Bor Fan Soils*

AhA Clayey

AhB Loamy or sandy

Ak *Meram and Sille Fan Soils*

AkA Clayey

AkB Loamy, locally sandy

Am *May Fan Soils*

AmA Loamy, locally clayey

AmB Shallow loamy, locally sandy, over soft lime and limestone

AmC Gravelly or sandy

An *Bayat Fan Soils*

AnA Clayey and loamy

As *Ayran Fan Soils*

AsA Clayey, locally complex loamy and sandy

AsB Sandy and gravelly

Au *Soils of Medium-Sized Fans*

AuA Clayey and loamy

AuB Gravelly and sandy

AuC Volcanic angular-cobbly

Aa Çamurluk Fan Soils The River Çamurluk enters the Basin from the south near Karaman. Deposits are exceptionally pale.

AaA Light-brown clayey (Profile 21 and Table 6) are very deep yellowish-brown and light-yellowish-brown (10YR 5.5/4) calcareous clay-loam or clay with a clear structural B horizon (locally illuvial), secondary lime segregation throughout the profile and commonly gypsum veins at 40–80 cm. They are flat and level. They are moderately well drained and slightly saline except near the boundary with regularly and frequently flooded Marsh Soils (MfA) where they are salt-affected and poorly drained.

They are uniform except in colour, which is grayish-brown to pale-brown (10YR 5/2.5 to 6/3.5) south-east of Kilbasan. They occur north of Karaman. Difficulties in finding the eastern and north-eastern boundaries were caused by their similarity in colour and texture to the Marl Soils (LmA). Most are irrigated and under wheat.

AaB Predominantly loamy are very similar to AaA except in texture which is loamy. Pebbles and marine shells are found throughout the profile; the shells are fossils from the limestone south of Karaman. They occur near Karaman as homogeneous and well-manured soil used for irrigated horticulture.

Table 6. Analytical data of Profile 21.

Horizon	Depth (cm)	Particle-size distribution			pH		$CaCO_3$ eq. (%)	org. C (%)
		< 2μm	2–50μm	> 50μm	H_2O	0.01 M $CaCl_2$		
Ap	0–20	14.2	54.7	30.1	7.80	7.20	64.8	0.63
B1	20–30	13.3	53.0	33.7	7.90	7.15	67.7	0.38
B2t	30–90	13.9	55.9	30.2	7.80	7.45	67.1	0.34

Tablo 6. Profil 21'e ait analitik bilgiler.

Profile 21.
Profil 21.

AaA Light-brown clayey Çamurluk Fan Soils

Great Konya Basin, Karaman Area, 21.5 N, 117.1 E, alt. about 1013 m, 24–7–1966 (van der Pouw)

Geomorphology: alluvial fan
Parent material: highly calcareous clay-loam
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: moderately well drained, watertable deeper than 10 m
Moistness: dry to 60 cm, slightly moist below 60 cm
Salinity: salt free
Biology: 0–20 cm common fine and medium roots, 20–160 cm few fine roots; common biopores to 160 cm
Land-use: dry-farming, fallow
Classification: 1964 Typic Ustochrept
1967 Typic Xerochrept

Soil description of Profile 21.

Ap 0– 20 cm light-yellowish-brown (10YR 6/4) clay-loam, 10YR 7/3 when dry, with a moderate fine, medium and coarse subangular-blocky structure; slightly hard; very friable; slightly plastic; sticky; mesopores and macropores; clear smooth boundary.

B1 20– 30 cm light-yellowish-brown (10YR 6/4) clay-loam, 10YR 7/3 when dry; moderate very coarse subangular-blocky structure breaking to weak very fine and fine subangular-blocky elements; slightly hard; very friable; slightly plastic slightly-sticky;

common mesopores and macropores; few to common fine shell fragments; clear smooth boundary.

B2t 30– 90 cm yellowish-brown (10YR 5/4) clay, 10YR 6/3 when dry; moderate coarse and very coarse angular-blocky structure breaking to moderate fine, angular blocky elements; hard; very friable; slightly plastic and sticky; common mesopores and macropores; few fine shell fragments; few krotovinas; faint clay-coatings; gradual smooth boundary.

B3tca 90–160 cm yellowish-brown (10YR 5/4; 10YR 6/3 when dry) clay; few fine distinct brownish-yellow (10YR 6/7) mottles; weak coarse and very coarse angular-blocky structure breaking to moderate fine angular-blocky elements; hard; very friable; slightly plastic and sticky; common mesopores and macropores; common fine and medium distinct white very hard lime concretions; faint clay-coatings.

This profile has an ochric epipedon and a cambic horizon.

Ab Former Backswamp Soils Some large alluvial fans as of the Çarşamba and the Çamurluk have extended their finest-textured deposits as deltas into the frequently flooded centre of the Basin. In this semi-lacustrine marsh with the arid climate swelling heavy-clays, often with vertic features, have formed.

A few other basins at the foot of bajadas or small fans as between Yeniköy and Badak (Bor Area), have similar soils.

They have been called Former Backswamp Soils, according to the current terminology for such areas. Their clay mineralogy is described by van der Plas & Schoorl in Part B.

AbA Predominantly grayish swelling clayey (Fig. 34, Profile 22 and Table 7) are grayish-brown (10YR 4/2) heavy-clays, fine angular and subangular blocky in the A horizon, coarse angular-blocky or prismatic in the B horizon and vertic in the subsoil (i.e. slickensides and parallelepipedal elements with intersecting planes). The surface is a mulch of fine angular elements, formed by churning. The top 50–80 cm has wide cracks when dry. The cracks close after the soil is wetted. Lime segregation is weak but commonly there is a horizon with abundant gypsum segregation as veins and clusters of fine crystals. They are flat and level. Most are moderately well to poorly drained and are moderately salt-affected, mainly internally. They are uniform except in depth to lacustrine marl substratum, which varies between 150 and 500 cm. They occur at the foot of the May and Çarşamba fans (Çumra Area) and the Bor Fan. They are under dry wheat, with one irrigation in spring. Low-salt-affected areas are ranged. For more details see Driessen & de Meester (1969).

AbB Predominantly brownish swelling clayey (Fig. 35, Profile 23) are similar to AbA, except in the dark-brown (10YR 4/3) colour of the solum. This brown clay extends in clear tongues (filled cracks?) into dark-gray subsoil. They occur between Dedemoğlu and Küçükköy (Çumra Area).

AbC Mainly moderately shallow non-swelling clayey or loamy over soft lime or marl are shallow or moderately shallow brown or grayish-brown clays or loams with angular and subangular blocky structure over carbonatic clay (marl) or soft lime.

Table 7. Analytical data of Profile 22.

Horizon	Depth (cm)	Particle-size distribution ($-CaCO_3$) < 2μm	2–50μm	> 50μm	$CaCO_3$ eq. (%)	C/N
Ap1	0– 9	80.6	13.6	5.8	17.3	7.3
Ap2	20– 30	79.3	15.9	4.8	17.6	7.7
B1	40– 50	81.1	13.8	5.1	18.0	8.8
B2	75– 85	79.2	15.6	5.1	17.8	9.0
B3	100–110	78.2	17.5	4.3	16.8	9.0
C1	120–130	77.1	16.5	6.4	–	7.4

Depth (cm)		SiO_2 %	Fe_2O_3 %	Al_2O_3 %	TiO_2 %	CaO %	MgO %	SO_3 (max.) %
0– 9	soil	45.4	5.8	16.1	0.71	10.9	2.4	1.7
20– 30	soil	44.3	5.7	16.2	0.72	9.5	3.2	–
40– 50	soil	45.3	5.8	16.4	0.72	10.8	3.0	1.0
75– 85	soil	45.3	5.8	16.2	0.75	10.5	3.1	0.7
100–110	soil	45.7	5.7	16.2	0.73	10.4	3.0	1.4
120–130	soil	42.8	5.7	15.1	0.69	13.1	2.7	–

Depth	pH	ECe	CEC	ESP	Depth	pH	ECe	CEC	ESP
0–10	7.62	0.43	43.3	2.82	60– 70	6.81	6.79	–	–
10–20	7.58	0.50	–	–	70– 80	6.71	10.51	45.6	3.12
20–30	7.50	0.64	–	–	80– 90	6.67	12.04	–	–
30–40	7.34	0.89	44.7	3.01	90–100	6.62	10.98	–	–
40–50	7.18	1.84	–	–	100–110	6.60	10.54	–	–
50–60	6.94	3.27	–	–	110–120	–	10.23	–	–

Tablo 7. Profil 22'ye ait analitik bilgiler.

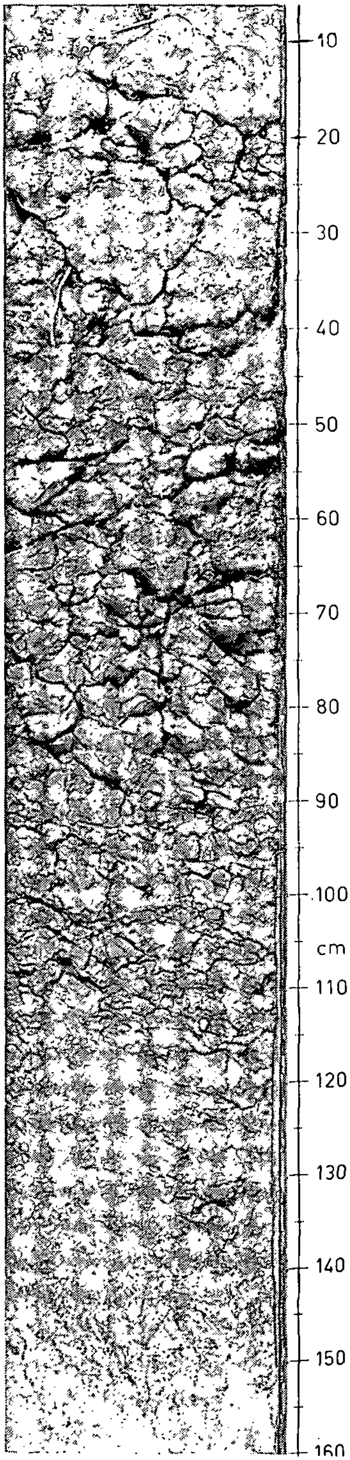


Fig. 34. Profile no 22.
Şekil 34. Profil no. 22.

AbA Predominantly grayish swelling clayey Former Backswamp Soils.

Great Konya Basin, Çumra Area, 67.1 N, 90.2 E, alt. about 1005 m, 9–6–1964 (Driessen)

Geomorphology: former backswamp of fan delta
Parent material: clay
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: Well drained, except where watertable is high, watertable deeper than 250 cm
Moistness: dry to below 250 cm
Salinity: saltfree
Biology: common fine roots throughout the profile
Land-use: dry-farming, wheat
Classification: 1964 Entic Grumustert
1967 Entic Chromoxerert

They lack vertic features and cracks are small or absent. Calcareous segregation is strong locally and traces of biological activity are often observed. They are flat and level. They vary in depth of surface soil, texture and drainage. The thickness of the clay layer (over carbonatic clay) decreases towards the centre. The boundary with the Marl Soils (Lm) is indistinct. They occur near Abditolu (Çumra Area) and in the Bor Area. They are partly under dry wheat with a flooding in spring, yields are poor. Poorly drained and salt-affected areas are ranged.

AbD Dark-gray organic and carbonatic clayey (Profile 24) are shallow to moderately shallow dark-gray (10YR 3.5/1) clay over gray-brown carbonatic clay. Locally they are very deep with wide cracks in the surface soil but no vertic features. They have a well developed structural B horizon and the upper part contains fine very hard lime concretions. Shells and shell fragments occur throughout the profile. They are flat and level. They are uniform except in depth and occurrence of cracks; and occur only south of Hamidiye (Karaman Area).

The area was only ten years ago a marsh but has been drained and is now only

Soil description of Profile 22.

Ap1	0– 9 cm	light-brownish-gray to grayish-brown (10YR 4.5/2) self-mulching clay-loam to clay; moderate medium granular structure; very hard when dry, soft to slightly hard when moist and slightly sticky, plastic when wet; few prominent calcareous concretions; few macropores, common mesopores; clear wavy boundary.
Ap2	9– 37 cm	light-brownish-gray to grayish-brown (10YR 4.5/2) clay-loam to clay, moderate coarse angular-blocky structure; very hard when dry, slightly hard when moist and slightly sticky, plastic when wet; few calcareous concretions; few macropores, common mesopores; gradual wavy boundary.
B1	37– 62 cm	grayish-brown (10YR 5/2) clay; strong coarse angular-blocky structure; very hard when dry, hard when moist, slightly sticky and very plastic when wet; few small calcareous concretions; few macropores, common mesopores; gradual wavy boundary.
B21	62– 93 cm	grayish-brown (2.5Y 4.5/2 moist) clay; strong coarse angular-blocky structure; parallelepipedal elements and intersecting slickensides; consistency like B1 horizon; few small calcareous spots and concretions; few faint rust spots; few macropores and mesopores; gradual wavy boundary.
B22ca	93–118 cm	grayish-brown (2.5Y 4.5/2) clay; moderate medium angular-blocky structure; very hard when dry, slightly hard when moist and slightly sticky and plastic when wet; parallelepipedal elements, intersecting planes and slickensides; little fine gravel in lower part of horizon; common faint rust mottles; few macropores and mesopores; gradual wavy boundary.
B3ca	118–135 cm	light-gray (2.5Y 7/2) loam; massive and slightly cemented; very hard when dry slightly hard when moist, slightly sticky, plastic when wet; few shell fragments; common gravel diam. 1–2 mm; clear wavy boundary.
IIC1	135–151 cm	light-gray to light-brownish-gray (2.5Y 6.5/2) loam; other characteristics as C1; transition to IIC2; clear wavy boundary.
IIC2	151–160 cm	light-brownish-gray (2.5Y 6/2) loam (marl); massive; slightly sticky, plastic when wet; few macropores and mesopores.

This profile has an ochric epipedon and a cambic horizon, slickensides and cracks.

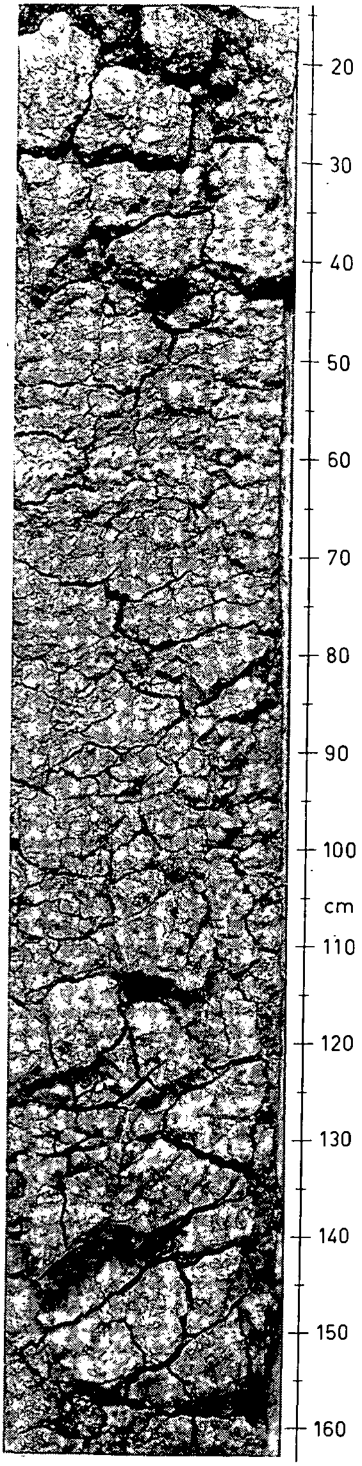


Fig. 35. Profile no 23.
Şekil 35. Profil no. 23.

AbB Predominantly brownish swelling clayey Former Backswamp Soils

Great Konya Basin, Çumra Area, 67.4 N, 85.8 E, alt. about 1005 m, 6–9–1965 (Groneman)

Geomorphology: alluvial plain
Parent material: clay
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: Moderately well drained, watertable usually about 2 m according to irrigation
Moistness: 0–30 cm dry, 30–110 cm moist, 110–170 cm wet
Salinity: slightly salt-affected
Biology: 0–50 cm common roots, 50–150 cm few roots
Land-use: irrigated farming, wheat and melon
Classification: 1964 Entic Grumustert
1967 Entic Chromoxerert

Soil description of Profile 23.

Ap	0– 20 cm	brown (10YR 4.5/3) clay, pale-brown to brown (10YR 5.5/3) when dry; ploughed surface has very coarse, very hard clods breaking up into strong fine and very fine granular elements; sticky plastic when wet, very firm very hard when moist, extremely hard when dry; few macropores and mesopores; clear smooth boundary.
B1tca	20– 43 cm	brown (10YR 4.5/3) clay, pale-brown (10YR 6/3) when dry; compound moderate very coarse prismatic and moderate coarse angular-blocky structure; sticky plastic when wet, very firm when moist, very hard and extremely hard when dry; very few macropores and common mesopores; few medium prominent soft white calcareous concretions and few peds coated with discontinuous clay coatings; clear smooth boundary.
B2tca	43– 68 cm	brown (10YR 4.5/3) clay, pale-brown (10YR 6/3) when dry; moderate medium blocky structure; sticky and plastic when wet, firm when moist, very hard when dry. Common macropores and many mesopores; few medium prominent soft white calcareous concretions, very few gypsum veins and pseudomycelium; continuous clay coatings on the faces of the peds.
B3t	68– 93 cm	brown (10YR 4.5/3) clay, pale-brown (10YR 6/3) when dry; compound weak parallelepipedal structure elements with long axis tilted 50°–60° from horizontal and moderate coarse blocky structure; sticky, plastic when wet, firm when moist, very hard when dry; common macropores and mesopores; few discontinuous clay coatings and slickensides; few gypsum veins, pseudomycelia and very few gypsum crystals; gradual irregular boundary.
C1cs	93–120 cm	brown (10YR 4.5/3) clay, pale-brown to brown (10YR 5.5/3) when dry; slickensides, wedge-shaped and parallepipedal strong elements; sticky plastic when wet, firm when moist, very hard when dry; few macropores and mesopores; many coarse distinct reddish-yellow (5YR 6/6) mottles; common gypsum veins, and many gypsum crystals and common crystal clusters; at 102 cm few thick roots of reeds and camelthorn; common distinct dark-gray (10YR 4.5/1) mottles; gradual irregular boundary.
C2cs	120–170 cm	dark-gray to gray (10YR 4.5/1) clay, gray to light-gray when dry; many slickensides up to 20 cm wide, wedge-shaped and parallelepiped strong elements; sticky plastic when wet, firm when moist, very hard when dry; few macropores and mesopores; many coarse distinct mottles (5YR 6/6) with clear boundaries; few gypsum veins, pseudomycelium and gypsum crystals; some surface soil on the faces of cracks.

This profile has an ochric epipedon and a cambic horizon, slickensides and cracks.

Profile 24.
Profil 24.

AbD Dark gray organic and carbonatic clayey Former Backswamp Soils

Great Konya Basin, Karaman Area, 32.4 N, 122.6 E, alt. appr. 1010 m, 16–8–1966 (de Wit)

Geomorphology: aluvial deposit
Parent material: highly calcareous clay
Relief and slope: flat or concave, level

Stoniness: Class 0
Hydrology: imperfectly or somewhat poorly drained, watertable about 10 m
Moistness: 0–25 cm dry, 25–50 cm slightly moist, deeper than 50 cm moist
Salinity: saltfree
Biology: few large and very large biopores (old roots), well rooted
Land-use: drainage started 7 years ago; natural marsh vegetation burnt this year in preparation for crops
Classification: 1964 Typic Normaquept
1967 Typic Haplaquept

Soil description of Profile 24.

A1 0– 6 cm very dark-gray (10YR 3/1) clay, gray (10YR 5/1) when dry; moderate fine medium subangular-blocky structure; large surface cracks 1–5 cm wide; hard when dry, very friable when moist, slightly sticky slightly plastic when wet; many mesopores and macropores; much organic material; many fine, few medium and large roots; common fine shells and shell fragments; clear smooth boundary

B21 6– 70 cm dark-gray (10YR 4/1) when moist) clay, gray (10YR 5/1) when dry; strong very coarse prismatic structure, subdivided into strong very thick platy coarse and very coarse angular-blocky elements; hard when dry, firm when moist, sticky slightly plastic when wet; few mesopores and macropores,; many distinct coatings on the faces of all structure elements; common fine shells and shell fragments; few distinct very fine white calcareous concretions; diffuse smooth boundary.

B22 70–160 cm dark-gray (10YR 4/1) clay, gray (10YR 5/1) when dry; weak coarse and very coarse prismatic structure, subdivided into strong coarse and very coarse angular-blocky elements; very hard when dry, friable when moist, sticky and plastic when wet; common mesopores and macropores; few fine and medium roots; common distinct fine and medium very hard white calcareous concretions; common coatings on the faces of all structural elements; common fine shells and shell fragments

Remark: the soil surface shows large cracks (1–5 cm wide)
This profile has an ochric epipedon and a cambic horizon.

Profile 25.
Profil 25.

AbE Aeolian clayey (ridge)

Great Konya Basin, Konya Area, 78.2N, 82.9E, alt. 1000.5 m, 24–5–1967 (Ridders & Melitz)

Geomorphology: pseudo sand(clay) ridge
Parent material: calcareous clay over marl
Relief and slope: normal, slightly undulating
Stoniness: Class 0
Hydrology: well drained, good permeability, watertable 150 cm
Moistness: dry
Salinity: slightly salt-affected
Biology: few roots to 140 cm, rodent holes to 120 cm

Land-use: dry-farming, wheat
Classification: 1965 Typic Calciorthid
1967 Typic Calciorthid

Soil description of Profile 25.

Ap	0– 15 cm	dark-gray (10YR 4/1) silty clay-loam; weak coarse subangular-blocky structure; very friable when moist; macropores and mesopores; gradual smooth boundary.
A12	15– 70 cm	dark-gray (10YR 4/1) clay-loam; moderate coarse subangular-blocky structure; friable when moist; calcareous concretions at 50 cm; macropores and mesopores; diffuse smooth boundary.
B21	70–110 cm	gray (10YR 5.5/1) gypsiferous (about 10% gypsum) silty clay-loam; weak coarse angular-blocky structure; friable when moist; mesopores and macropores; gradual irregular boundary.
B22cs	110–130 cm	gray to light-gray (2.5Y 6/0) calcareous and gypsiferous clay-loam; weak coarse angular-blocky structure; friable when moist; mesopores and macropores; few faint mottles of iron; clear smooth boundary.
IIB2	> 130 cm	white to light-gray (2.5Y 7.5/2) gypsiferous marl; compound prismatic structure; slightly sticky slightly plastic when wet; distinct common iron mottles

This profile has an ochric epipedon, a cambic horizon and a gypsic horizon.

slightly salt-affected. The surface soil still contains roots of marsh vegetation. Most is under wheat but also melon and sunflower, locally irrigated.

AbE Aeolian clayey (ridge) (Profile 25) is unlike other Ab units but is included because the soils are composed of windborn clay presumably originating from the swelling clayey Former Backswamp Soils. They are deep dark-gray (10YR 4/1) clay-loams to clays with little or no profile. They form a well drained moderately internally saline slightly undulating ridge 3 to 5 m high between Abditolu and Hayıroğlu (Çumra Area). They are dry-farmed amidst a region of irrigated agriculture.

Ac Çarşamba Fan Soils The deposits of the Çarşamba form a delta rather than an alluvial fan. About 7 km below Çumra the river splits into three branches which are now canalized for irrigation.

The soil pattern and some deserted river channels indicate that an important branch used to run eastwards from Çumra towards Hotamış Gölü.

The mainly clayey deposits indicate that the River Çarşamba has always had an almost steady flow. Its flow is now regulated even more by the Apa Dam. For details see Driessen & de Meester (1969).

AcA Clayey (Figs. 36, 37 and 38, Profile 26 and Table 8) are deep dark-brown (10YR 4/5) clay or clay-loam with a subangular structure in the A horizon and an angular-blocky structural B horizon. There is weak calcareous segregation (white spots and pseudomycelium) at various depths. The soils are well homogenized by large worms down to about 100 cm. They are well drained and moderately salt-affected around Çumra. The lower parts are strongly salt-affected. They are flat and level.

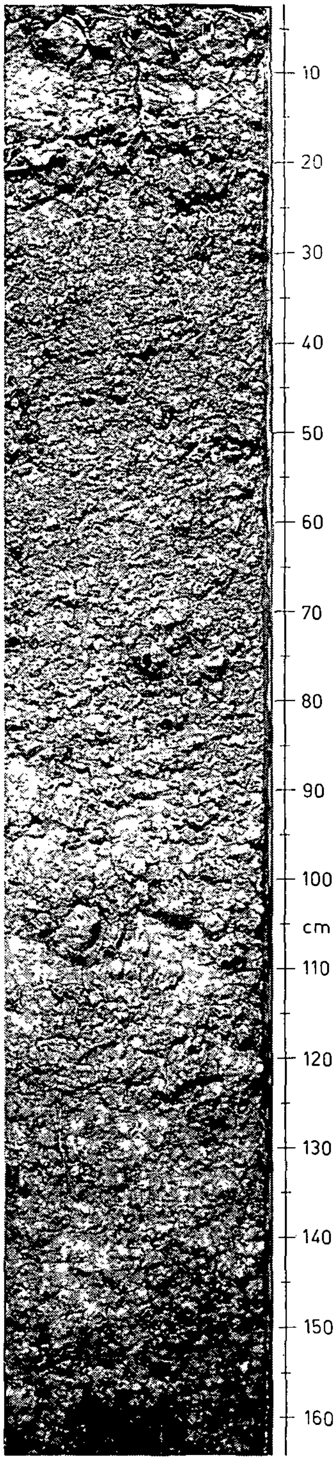


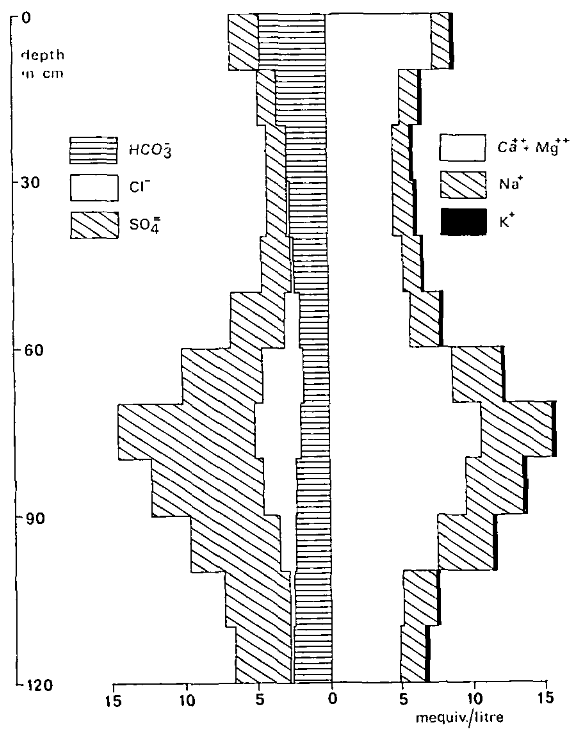
Fig. 36. Profile no 26.
Şekil 36. Profil no. 26.

AcA Clayey Çarşamba Fan Soils

Great Konya Basin, Çumra Area, 58.0N, 82.7E, alt. about 1008 m, 11–5–1964 (Driessen)

Geomorphology: alluvial plain or delta
Parent material: calcareous clay
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: well drained, watertable influenced by irrigation, usually 170 cm
Moistness: moist
Salinity: saltfree
Biology: roots plentiful down to 160 cm
Land-use: parking place for farm machinery
Classification: 1964 Typic Calciorthid
1967 Typic Calciorthid

Fig. 37. Ion balance of Profile no 26.



Şekil 37. Profil no. 26'da iyon dengesi.

Fig. 38. Irrigated apple orchard on clayey Çarşamba Fan Soil (AcA). At the Experimental station, Çumra Area.

Şekil 38. Çumra bölçesinde, Sulu Ziraat Deneme İstasyonunun, killi Çarşamba Nehri Yelpazesi Topraklarında (AcA) sulanan elma ağaçları.

Soil description of Profile 26.

Ap	0– 22 cm	brown to dark-brown (7.5YR 4/3) clay with a moderate coarse angular-blocky structure; slightly sticky slightly plastic when wet, very friable when moist, hard when dry; many macropores and mesopores; few fine to medium soft white calcareous pockets; common very fine, coloured gravel; clear wavy boundary.
B1	22– 32 cm	brown to dark-brown (7.5YR 4/3) clay; 10YR 5/3 when dry; moderate medium prismatic structure; slightly sticky slightly plastic when wet, very friable when moist, hard when dry; many macropores and mesopores; few fine to medium soft white calcareous pockets; little very fine gravel; clear wavy boundary.
2ca	32– 83 cm	brown to dark-brown (7.5YR 4/3) clay; 10YR 5/3 when dry; weak medium subangular-blocky structure; slightly plastic when wet, very friable when moist, hard when dry; many macropores and mesopores; few fine to medium soft white calcareous pockets; diffuse boundary.
B3ca	83–121 cm	brown to dark-brown (7.5YR 4/3) loam, 10YR 6/3 when dry; weak to moderate medium angular-blocky structure; slightly sticky slightly plastic when wet, friable when moist, hard when dry; many macropores and mesopores; few coloured sandgrains; common moderate fine to medium calcareous concretions; diffuse boundary with salt efflorescence from 117 cm.
C1	121–144 cm	brown to dark-brown (7.5YR 4/3) clay, 10YR 6/3 when dry with a moderate to strong medium angular-blocky structure; slightly sticky slightly plastic when wet, firm when moist, hard when dry; many mesopores and macropores;

Table 8. Analytical data of Profile 26.

Horizon	Depth (cm)	Particle-size distribution						CaCO₃eq. (%)	org. C (%)	N (%)
		< 2μm		2–50μm		> 50μm				
		$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$			
Ap	0– 22	60.0	42.7	20.0	36.5	20.0	20.8	22.6	1.11	0.083
B1	22– 32	54.7	47.6	29.3	39.3	17.0	13.1	23.2	0.77	0.082
B2	32– 83	57.5	47.8	28.2	38.7	14.3	13.5	25.2	0.73	0.073
B3	83–121	47.0	38.7	33.4	43.6	19.6	17.7	30.7	0.47	0.044
C1	121–144	56.5	48.0	35.6	45.5	7.9	6.5	27.9	0.59	0.043
IIBb	144–163	63.7	75.3	35.0	24.5	1.3	0.2	10.4	0.68	0.064

Depth	pH	ECe	CEC	SEP	Depth	pH	ECe	CEC	ESP
0–10	7.58	0.85	24.1	1.79	60– 70	7.79	1.22	—	—
10–20	7.55	0.64	—	—	70– 80	7.82	1.49	27.5	3.45
20–30	7.60	0.29	—	—	80– 90	7.88	1.32	—	—
30–40	7.59	0.60	26.1	1.76	90–100	7.89	1.07	—	—
40–50	7.62	0.65	—	—	100–110	7.90	0.75	—	—
50–60	7.72	0.81	—	—	110–120	7.90	0.66	23.8	2.73

Tablo 8. Profil 26'ya ait analitik bilgiler.

few prominent fine to medium calcareous concretions; few coloured sandgrains; diffuse boundary with salt efflorescence to 136 cm.

IIBb 144–163 cm dark-brown (7.5YR 3.5/5) clay; moderate to strong medium angular-blocky structure; slightly sticky slightly plastic when wet, firm when moist, very hard when dry; many macropores and mesopores; common prominent medium calcareous concretions and nodules; few coloured sandgrains.

This profile has an ochric epipedon, a cambic horizon and a calcic horizon.

Profile 27.
Profil 27.

AcC Loamy Çarşamba Fan Soils over sandy subsoil

Great Konya Basin, Çumra Area, 59.5N, 86.0E, alt. about 1007 m, Aug. 1964 (Driessen)

Geomorphology: alluvial fan or delta
Parent material: calcareous sandy loam
Relief and slope: flat, level
Stoniness: Class 0.
Hydrology: internally moderately well drained, externally poorly drained, watertable 120 cm
Moistness: moderately dry to moist, wet at 100 cm
Salinity: saltfree
Biology: no remarks
Land-use: ranging
Classification: 1964 Typic Calciorthid
1967 Typic Calciorthid
Soil description of Profile 27.

A11 0– 2 cm grayish-brown (10YR 4.5/2) sandy loam pale-brown (10YR 6/2) when dry; weak fine or thin platy structure grade; slightly sticky slightly plastic when wet, very friable when moist, soft when dry; no mottling; few macropores; abrupt smooth boundary.

A12 2– 34 cm dark-grayish-brown (10YR 4/2) sandy loam to loam; pale-brown (10YR 6/2) when dry; strong very coarse prismatic structure, prismatic units are composed of angular-blocky elements; sticky plastic when wet, firm when moist, hard to very hard when dry; coloured sandgrains of serpentine, quartz, black and red minerals; few calcareous concretions; common macropores, few mesopores; clear smooth boundary.

B2ca 34– 44 cm dark-gray (10YR 5.5/1.5) sandy loam; coarse thick strong prismatic structure; sticky plastic when wet, firm when moist, hard to very hard when dry; common medium soft calcareous mottles; coloured sandgrains; common macropores, few mesopores; clear smooth boundary.

C1ca 44– 80 cm light-brownish-gray (10YR 6/2) sandy loam; structureless massive; sticky slightly plastic when wet, very friable when moist; common medium soft calcareous mottles; few macropores; few coloured sandgrains; clear smooth boundary.

C2 80–100 cm like C1ca with fewer calcareous mottles.

C3 100–130 cm pale-brown (10YR 6/3) sand; structureless single grain; many coloured sandgrains.

This profile has an ochric epipedon and a cambic and a calcic horizon.

They are fairly uniform but include some loamy areas, too small to be mapped separately. They occur around Çumra and around Üçhüyükler (Çumra Area). They are irrigated for wheat, sugar-beet, and apples and the famous Çumra melons.

AcB Loamy, locally sandy are deep, brown (10YR) loams or sandy-loams like AcA in structure and lime segregation. They are well drained, saltfree or slightly salt-affected, and flat and level. They are complex as might be expected in the plain of a meandering river. They occur mainly near the present river course and also near an old branch south of the sandridge. Land-use is similar to AcA.

AcC Loamy, over sandy subsoil (Profile 27) are moderately deep dark-grayish-brown (10YR 4/2) loam, becoming sandier deeper, with a calcic horizon. They are strongly salt-affected and poorly drained. They are somewhat complex, varying in depth of the loamy subsoil, and occur in an irrigated area between Güverçinlik and Üçhüyükler (Çumra Area). They are under irrigated crops with poor results or are ranged.

Ad Deli Fan Soils These soils occur near Kurtderesi Köy (Karaman Area). The Deli is a small torrent which cuts through the Neogene structural terraces south-west of Karaman, before forming a small alluvial fan. It dries up in summer. The soils are moderately coarse-textured near the fan's apex, gradually becoming medium and fine towards its base. Locally they are stratified.

*Ad*C *Clayey* (Profile 28) are very deep to deep yellowish-brown (10YR 5/4) clays and clay-loams with dark fine gravel throughout the profile and a clear Ap and a well developed structural B horizon. A horizon with secondary Ca-carbonate segregation was recorded locally in the north, where the clay becomes more fine-textured and shows vertic features (wide cracks). They are well drained, slightly internally salt-affected and are flat and level. They are under wheat.

AdB Loamy are deep yellowish-brown (10YR 4.5/4) calcareous loamy-sand and loam without secondary carbonates. They are stratified and contain fine gravel and fossil marine shells from the limestones south of Karaman.

They are well drained, saltfree and flat and nearly level. A stream channel runs down the middle of the AdB unit and is connected with a drainage canal 3.5 km north-west of Karaman. River sand is deposited where the stream crosses the main road. This sand also contains fossil shells and is quarried for building.

Ae Selereki Fan Soils The deposits of the Selereki cover a large area north of Selereki (Karaman Area). They were deposited over Lacustrine Marls which occur in the subsoil, especially along the western and north-western boundary. There flooding gives the soil a reduction colour like that of the Marl Soils and makes the boundary difficult to distinguish. They are medium-textured near the fan apex, gradually becoming finer towards the base.

AeA Locally shallow clayey over marl (Profile 29) are deep brown to grayish-brown (10YR 5/4 to 10YR 5/2) very calcareous clays, locally moderately shallow or even shallow over marl. North of the line Çanhasan-Suduragı the soil is mainly grayish, south of it mainly yellowish-brown. They have an Ap and a clear structural, locally illuvial B horizon. A calcic horizon consisting of hard calcareous concretions and soft calcareous pockets is common. In the north shell fragments occur in the surface layer.

They are poorly drained (high watertable) but only moderately internally salt-affected. Yields of dry wheat are relatively high. The area east of Sudarağı is ranged.

AeB Loamy (Profile 30) are very deep brown to yellowish-brown (10YR 4.5/3.5) loam to clay-loam with Ap, structural B and locally argillic horizons. They are well drained and saltfree or slightly salt-affected. They are rather complex in texture. Medium-textured soils occur north of Çanhasan, whereas the soils south of the village tend to be clay-loam. Around Aşıran is a low ridge of yellowish-brown sandy-clay-loam surrounded by grayish-brown soils. Wheat is the main crop. With a supplementary supply of pumped irrigation water sunflower is grown near Selereki and sugar-beet near Aşıran.

Profile 28.
Profil 28.

AdA Clayey Deli Fan Soils

Great Konya Basin, Karaman Area, 18.3N, 113.0E, alt. about 1017 m, 24–7–1966 (van der Pouw)

Geomorphology: alluvial fan
Parent material: calcareous clay loam
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: drained, watertable deeper than 10 m
Moistness: to 170 cm dry, below 170 cm slightly moist
Salinity: saltfree to slightly salt-affected
Biology: 0–25 cm common fine and medium roots, 25–170 cm few fine roots; few biopores throughout the profile.
Land-use: dry-farming, fallow
Classification: 1964 Typic Haplargid
1967 Typic Haplargid

Soil description of Profile 28.

Ap	0– 25 cm	yellowish-brown (10YR 5/4) clay-loam, 10YR 6/4 when dry; moderate coarse angular to subangular-blocky structure; slightly hard; very friable; slightly plastic and slightly sticky; common mesopores and macropores; clear smooth boundary.
B1	25– 54 cm	yellowish-brown (10YR 5/4) clay-loam, 10YR 6/4 when dry; weak coarse angular-blocky structure; slightly hard; very friable; slightly plastic slightly sticky; common mesopores and macropores; few fine faint white extremely hard calcareous concretions; few fine shell fragments; few krotovinas; clear smooth boundary.
B2t	54–120 cm	yellowish-brown (10YR 5/4) clay-loam, 10YR 6/4 when dry; moderate medium and coarse angular-blocky structure; hard very friable; slightly plastic sticky;

few to common mesopores and macropores; few fine distinct white extremely hard calcareous concretions; few fine shell fragments; few krotovinas; faint clay-coatings on the peds; gradual smooth boundary.

B3t 120–170 cm yellowish-brown (10YR 5/4) clay loam, 10YR 6/4 when dry; weak coarse angular-blocky structure; slightly hard, very friable; slightly plastic sticky; few to common mesopores and macropores; few fine distinct white extremely hard calcareous concretions; few fine shell fragments; faint clay-coatings on the ped.

Remark: few fine dark gravel throughout profile.

This profile has an ochric epipedon, a cambic and an argillic horizon.

Profile 29.
Profil 29.

AeE Locally shallow clayey Selereki Fan Soils over marl

Great Konya Basin, Karaman Area, 131.0N, 30.5E, alt. about 1008 m, 22-8-1966 (van der Pouw)

Geomorphology: alluvial fan
Parent material: calcareous clay
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: imperfectly drained, watertable 160 cm
Moistness: 0–30 cm dry, 30–120 cm slightly moist to moist
Salinity: saltfree
Biology: 0–30 cm common fine and medium roots, below 30 cm few fine roots; undisturbed subsoil at 150 cm
Land-use: dry-farming, fallow
Classification: 1964 Typic Haplargid
1967 Typic Haplargid

Soil description of Profile 29.

Ap 0– 25 cm grayish-brown (10YR 5/2) clay, 10YR 6.5/1 when dry; moderate fine medium and coarse subangular-blocky structure; slightly hard; very friable; slightly plastic sticky; few large and very large biopores; common mesopores and macropores; clear smooth boundary.

B1 25– 55 cm grayish-brown (10YR 5/2) clay, 10YR 6/1 when dry; moderate very coarse angular-blocky structure; slightly hard to hard; very friable; slightly plastic slightly sticky; few large and very large biopores; common mesopores and macropores; few fine and medium distinct white soft segregations; clear smooth boundary.

B2tca 55– 86 cm grayish-brown (10YR 5/2) clay, 10YR 6/1 when dry; strong coarse angular-blocky structure; slightly hard to hard; very friable; slightly plastic, sticky; few large and very large biopores; common mesopores and macropores; common fine and medium prominent white soft calcareous segregations; faint clay coatings; gradual smooth boundary.

IIB2tca 86–130 cm light-yellowish-brown to light-olive-brown (2.5Y 5.5/4) silty clay, 2.5Y 7/4 when dry; common fine faint brownish-yellow (10YR 6/8) mottles; strong coarse angular-blocky structure; slightly hard to hard; very friable; slightly plastic sticky; few large and very large biopores; common mesopores and macropores; common fine and medium prominent white soft calcareous segregations; faint clay coatings; gradual smooth boundary.

IICca 130–160 cm light-yellowish-brown (2.5Y 6/4) silty clay, 2.5Y 7/4 when dry; common fine faint brownish-yellow (10YR 6/8) mottles; massive; slightly hard; very friable; slightly plastic slightly sticky; few mesopores and macropores; common fine and medium prominent extremely hard calcareous concretions.

This profile has an ochric epipedon, a cambic, an argillic and a calcic horizon.

Profile 30.
Profil 30.

AeB Loamy Selereki Fan Soils

Great Konya Basin, Karaman Area, 31.7N, 131.8E, alt. about 1010 m, 26–8–1966 (de Wit)

Geomorphology: alluvial fan
Parent material: calcareous loam to clay-loam
Relief and slope: flat or concave, level or nearly level
Stoniness: Class 0
Hydrology: moderately well to well drained, watertable deeper than 10 m
Moistness: 0–23 cm dry, deeper than 23 cm slightly moist, moist at 175 cm
Salinity: saltfree
Biology: common krotovinas 27–130 cm, common large biopores 40–175 cm, roots down to 175 cm (bottom pit)
Land-use: dry-farming, wheat, sometimes pump-irrigated, at present fallow
Classification: 1964 Typic Haplargid
1967 Typic Haplargid

Soil description of Profile 30.

Ap1 0– 20 cm brown to pale-brown (10YR 5.5/3.5) sandy clay-loam, very pale-brown (10YR 7/3) when dry; moderate coarse and very coarse subangular clods and strong very fine to fine granular elements; slightly hard to hard when dry, very friable when moist, slightly sticky slightly plastic when wet; common mesopores and macropores; few fine quartz pebbles; few fine recent shell fragments; abrupt smooth boundary.

Ap2 20– 27 cm brown to pale-brown (10YR 5.5/3.5) sandy clay-loam, pale-brown to very pale-brown (10YR 6.5/5.5) when dry; very thick platy, breaking into medium and coarse angular-blocky elements; hard to very hard when dry, very friable when moist, slightly sticky slightly plastic when wet; few to common mesopores and common macropores; few fine and medium quartz and limestone pebbles; clear smooth boundary.

B1tg 27– 41 cm yellowish-brown to light-yellow-brown (10YR 5.5/3.5) loam, pale-brown to very pale-brown (10YR 6.5/3) when dry; weak medium compound prismatic, easily breaking into moderate fine and medium angular-blocky elements; slightly hard to hard when dry, very friable when moist, slightly sticky slightly plastic when wet; many mesopores and macropores, few to common faint fine iron mottles; common faint clay coatings on faces of small structural elements; gradual wavy boundary.

B21tg 41– 65 cm yellowish-brown (10YR 5/4) clay-loam, very pale-brown (10YR 7/3) when dry; moderately weak medium and coarse prismatic structure, easily breaking into

		strong fine and medium angular-blocky elements; hard when dry, friable when moist, sticky and slightly plastic when wet; few mesopores and macropores; few faint fine iron mottles; many distinct clay coatings on the faces of all elements; common krotovinas filled with strong fine and medium granular elements; few medium pebbles, few fine shell fragments; clear smooth boundary.
B22tg	65–110 cm	brown to pale-brown (10YR 5.5/3) sandy clay-loam, very pale-brown (10YR 7/3) when dry; moderate coarse and very coarse prismatic structure, easily breaking into strong fine and medium angular-blocky elements; hard when dry; friable to very friable when moist; sticky and slightly plastic when wet; few mesopores and macropores; many distinct fine iron mottles (7.5YR 5.5/8); gradual smooth boundary.
B3g	110–130 cm	brown to pale-brown (10YR 5.5/3.5) sandy-loam or loamy sand, very pale-brown (10YR 7/3) when dry; weak medium prismatic struture, locally massive; hard when dry, very friable when moist, slightly sticky slightly plastic when wet; few to common mesopores, common macropores; many distinct fine iron mottles (7.5YR 5.5/8); common very fine shell fragments; clear smooth boundary.
Cg	130–175 cm	yellowish-brown (10YR 5/4) stratified medium to coarse sand and loam, very pale-brown (10YR 7/3) when dry; structureless massive; hard when dry, loose when moist, non-sticky non-plastic when wet; many mesopores and macropores; few faint fine mottles, few fine pebbles; many very fine and few medium fossil shell fragments.

This profile has an ochric epipedon, a cambic and an argillic horizon.

Af Çakmak Fan Soils The Çakmak deposits lie between Bulgurluk and Azizıye in the Ereğli Area. The Çakmak is a torrent which has cut through the foothills of the Toros Mountains. These foothills consist largely of gravelly old bajada, whose lower parts form Dissected gravelly clayey Limestone Bajada Soils (BrD).

The river enters the plain near Çakmak Village and its deposits fan out over the Bajada Soils (BrB) which in this area are also derived from the old bajadas. Consequently, the Çakmak Fan Soils and the local BrB soils are very similar except for some profile characteristics: fan soils are much more stratified and show little or no pedogenesis (A–B zonality and secondary carbonates).

AfA Clayey (Profile 31) are very deep, brown to yellowish-brown (7.5YR 5/4 to 10YR 5/6) fine-gravelly loams to clay-loams with subangular-blocky structure down to about 100 cm and stratified subsoil. They are well homogenized with only a few white powdery calcareous pockets. They are well drained and predominantly saltfree. They are uniform except for some areas with sandy layers in the surface soil, and some depressions in the north-west of the fan and west of Bulgurluk which are finer-textured. More than half the area is under dry wheat. Other parts are subject to torrential floods two or three times a year. West of Bulgurluk and south of Ciller sugar-beet is grown with pump-irrigation.

AfB Loamy are similar to AfA except for a coarser texture and less uniformity. They occur near the apex of the fan where sandy and gravelly patches and layers occur in the usual pattern of a wild fluvial system. The land is farmed in small plots used for irrigated orchards and wheat.

Profile 31.
Profil 31.

AfA Clayey Çakmak Fan Soils

Great Konya Basin, Ereğli Area, 66.2N, 211.5E, alt. 1100 m, 11–7–1966 (van Beek)

Geomorphology: alluvial fan
Parent material: calcareous clay
Relief and slope: normal, undulating
Stoniness: Class 0, some pebbles
Hydrology: moderately well drained, watertable deeper than 10 m
Moistness: dry to 60 cm, subsoil slightly moist
Biology: below 36 cm subsoil partly disturbed, few very large and large biopores, few medium and common fine roots
Land-use: irrigated farming
Classification: 1964 Typic Haplorthent
1967 Typic Xerorthent

Soil description of Profile 31.

Ap	0– 27 cm	yellowish-brown (10YR 5/4) clay-loam, pale-brown (10YR 6/3) when dry; weak coarse angular-blocky structure; slightly hard when dry, very friable when moist, slightly sticky slightly plastic when wet; many macropores and mesopores; pores partially filled with faecal pellets; gradual smooth boundary.
C1	27– 46 cm	yellowish-brown (10YR 5/4) clay-loam, pale-brown (10YR 6/3) when dry; massive; slightly hard when dry, very friable when moist, slightly sticky slightly plastic when wet; many macropores and mesopores; many fine to coarse distinct brown (7.5YR 5/4) clayballs; clear smooth boundary.
C2	46– 58 cm	dark-grayish-brown (10YR 4/2) fine-gravelly sand, light gray (10YR 7/2) when dry; massive; soft when dry, very friable when moist, non-sticky and non-plastic when wet; common macropores and few mesopores; clear smooth boundary.
C3	58– 81 cm	dark-brown (10YR 4/3) loamy sand, pale-brown (10YR 6/3) when dry; massive; soft when dry, very friable when moist and slightly sticky and slightly plastic when wet; common macropores and few mesopores; common fine to coarse distinct brown (7.5YR 5/4) hard clayballs; gradual smooth boundary.
C4	81– 99 cm	yellowish-brown (10YR 5/4) clay-loam; weak medium prismatic; slightly sticky slightly plastic, very friable, soft; many macropores and mesopores; gradual smooth boundary.
C5	99–135 cm	dark-brown (10YR 5/3) sandy loam; massive; slightly sticky slightly plastic, very friable, slightly hard; many macropores and mesopores.

This profile has an ochric epipedon.

Ag Zanopa Fan Soils The deposits of the River Zanopa (or İvris) are near Ereğli. The river has a large annual discharge (Fig. 63) and is now regulated by several dams near the Village of İvris. The upper part of the fan is a widening valley, upstream from Ereğli with mainly coarse-textured soils. This valley must have been under cultivation with fruits and grapes for many centuries, as is witnessed by rock carvings of Hittite origin near İvris (Fig. 39). Near Ereğli, the river deposits fan out over the lacustrine sediments of the plain and the soils are clayey, becoming finer

Fig. 39. Hittite bas-relief near İvris in the Zanopa Valley.

Şekil 39. Zanopa vadisinde, İvris yakınlarında, Hitit kabartması.

textured towards the foot of the fan base. Around the foot are a semicircle of villages where saltfree groundwater approaches the surface. Below the fan is a zone of marsh (MfA) due to numerous springs.

The Zanopa Fan is completely irrigated by a well designed ancient irrigation system, which has been improved by elaborate waterworks recently.

AgA Clayey (Profile 32 and Table 9) are deep and very deep, brown (10YR 4.5/3) silty-clay-loams to clays with a clear Ap and a structural B horizon. They are well homogenized to about 100 cm. The texture becomes coarser with depth. In the subsoil sandy and gravelly strata are common. They are well drained and kept saltfree by the heavy continuous irrigation. However some salinity occurs at the foot of the fan in the transition to AgC. They are flat and nearly level. The unit is not very uniform. Numerous irrigation canals and dikes run through the area obscuring the original topography but observations indicate that coarser textured levee soils and heavier backswamp soils occur locally. A wide variety of commercial crops and fruits are grown under irrigation.

AgB Loamy or sandy are a complex of very deep, brown (10YR) gravelly loamy sands in the wide valley south-east of Ereğli. They are stratified, well drained, saltfree and the slopes have been built up into terraces. They are irrigated and divided into many small plots and walled gardens.

AgC Hydromorphic clayey are a complex of normal and hydromorphic moderately shallow grayish-brown waterlogged clay over lacustrine marl. In general they are poorly drained due to high watertable but only slightly saline.

They form a zone at the very base of the fan merging into Marsh Soils (Mf). Wheat is grown on the better drained patches. The rest is marshy range.

Ah Bor Fan Soils This fan is south-west of Bor. A narrow valley runs from Niğde to Bor where it opens out and the deposits fan out over the plain. The valley soils are medium and coarse-textured, those of the fan are fine-textured. The river flows throughout the year.

AhA Clayey (Profile 33) are deep or moderately shallow, brown to pale-brown (10YR 5.5/3) clay-loams with an angular-blocky structural B horizon over soft lime. Cemented layers occur locally between 50–100 cm, especially in the lower parts of the fan.

They are moderately well to poorly drained, moderately to strongly salt-affected, and flat and level. Near Bor they are under wheat but elsewhere they are used only as range.

AhB Loamy or sandy are stratified as is usual in the upper part of a river fan. Our limited data indicate brown loams. Drainage is good and they are saltfree. Wheat and fruit are grown with irrigation.

Ak Meram and Sille Fan Soils The deposits of the rivers Meram and Sille merge into a large alluvial fan on which is built the Town of Konya. The soils of both rivers may differ slightly but most of the fan is urban area or fenced garden, so a boundary

Table 9. Analytical data of Profile 32.

Horizon	Depth (cm)	Particle-size distribution (+$CaCO_3$)			pH		$CaCO_3$eq. (%)	C (%)
		< 2μm	2–50μm	> 50μm	H_2O	$CaCl_2$		
Ap	0– 26	27.5	55.1	17.4	7.72	7.23	36.7	1.21
B2	26– 90	29.6	52.5	17.9	7.92	6.85	35.4	0.70
B3	90–111	26.4	56.4	17.2	7.79	7.45	39.1	0.65
C1	111–128	21.5	50.6	27.9	8.04	7.13	48.3	0.51
C2	128–152	14.1	48.0	37.9	8.29	7.29	53.1	0.26
C3	152–173	12.9	35.4	51.7	8.37	7.25	51.5	0.35

Tablo 9. Profil 32'e ait analitik bilgiler.

Profile 32.
Profil 32.

AgA Clayey Zanopa Fan Soils

Great Konya Basin, Ereğli Area, 55.4N, 192.9E, alt. about 1075 m, 27–9–1967 (van der Linde & Ruessink)

Geomorphology: alluvial fan
Parent material: calcareous clay-loam
Relief and slope: flat, nearly level
Stoniness: Class 0
Hydrology: well drained, watertable deeper than 10 m
Moistness: moist
Salinity: saltfree
Biology: 0–26 cm common medium roots, 26–60 cm few medium roots, 0–60 cm few fine roots
Land-use: dry-farming, fallow
Classification: 1964 Typic Camborthid
1967 Typic Camborthid

Soil description of Profile 32.

Ap 0– 26 cm brown (10YR 4.5/3) silty clay-loam, pale-brown (10YR 6/2.5) when dry; ploughed clods, coarse medium angular-blocky; hard when dry, slightly sticky and slightly plastic when wet; abrupt smooth boundary.

B2 26– 90 cm brown (10YR 4.5/3) silty clay-loam; compound weak prismatic structure consisting of moderate medium subangular-blocky elements; friable; common biopores, mesopores and macropores; gradual smooth boundary.

B3 90–111 cm brown (10YR 5/3) silty clay-loam; compound very weak prismatic structure consisting of weak subangular-blocky elements; friable; common mesopores and macropores; clear smooth boundary.

C1 111–128 cm brown (10YR 5/2.5) clay-loam; structureless; friable; few mesopores and macropores; clear smooth boundary.

C2 128–152 cm brown (10YR 5/3.5) sandy loam; structureless; very friable; few macropores; abrupt smooth boundary.

C3 152–173 cm brown (10YR 5/3.5) sand; structureless; very friable; very few macropores.

This profile has an ochric epipedon and a cambic horizon.

Profile 33.
Profil 33.

AhA Clayey Bor Fan Soils

Great Konya Basin, Bor Area, 90.3N, 232.2E, alt. about 1045 m, 24–8–1967 (Ruessink)

Geomorphology: alluvial fan
Parent material: calcareous loam to clay-loam
Relief and slope: flat, level
Stoniness: Class 0.
Hydrology: well drained, watertable deeper than 10 m
Moistness: 0–90 cm dry, deeper than 90 cm moist
Salinity: moderately salt-affected
Biology: 0–30 cm common medium and fine roots; 30–60 cm few fine roots
Land-use: ranging
Classification: 1964 Typic Durorthid
1967 Typic Durorthid

Soil description of Profile 33.

A1	0–17 cm	brown (10YR 4.5/3) loam, moderate medium angular to subangular blocky structure; friable; common mesopores and macropores; clear smooth boundary.
B1	17–40 cm	brown to pale-brown (10YR 5.5/3) clay-loam; moderate medium angular-blocky and moderate platy structure; friable; common mesopores and macropores; abrupt smooth boundary.
B2	40–89 cm	brown (10YR 4.5/3) cemented layer (hardpan); very firm; no mesopores; few macropores; abrupt smooth boundary.
C	> 89 cm	soft lime.

This profile has an ochric epipedon, a cambic horizon and a duripan.

Profile 34.
Profil 34.

AkA Clayey Meram and Sille Fan Soils

Great Konya Basin, Konya Area, 87.4N, 53.1E, alt. about 1030 m, 28–9–1967 (Ridders)

Geomorphology: alluvial fan
Parent material: calcareous silty clay
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: moderately well drained, watertable deeper than 10 m
Moistness: 0–20 cm slightly moist, deeper moist to slightly moist
Salinity: saltfree
Biology: 0–50 cm few large, many medium and fine roots, below 50 cm many very large and large roots, common to few medium and fine roots
Land-use: wheat and orchard, at present weedy fallow
Classification: 1964 Typic Camborthid
1967 Typic Camborthid

Soil description of Profile 34.

A1	0– 22 cm	brown to dark-brown (10YR 4/3.5) silty clay, light-gray (10YR 7/1) when moist; compound very coarse prismatic and moderate coarse angular-blocky to prismatic structure; slightly hard to hard when dry; many mesopores and macropores; many vertical cracks; smooth clear boundary.
A2	22– 50 cm	brown to dark-brown (10YR 4/3) silty clay to clay; compound moderate to strong medium prismatic and medium to fine angular-blocky structure; firm to very firm when moist; few mesopores, many macropores; common fine gravel and remains of old dwelling down to 50 cm; deeper occasionally remains of pottery; at about 45 cm many shells; smooth diffuse boundary.
B1ca	50–113 cm	brown to dark-brown (10YR 4/3) silty clay to clay; compound moderate to strong and medium to coarse prismatic and fine to medium angular-blocky structure; very firm to extremely firm when moist; few mesopores; common macropores; calcareous mottling and few calcareous veins below about 70 cm; from 100 cm prominent fine calcareous concretions, veins and mottles; wavy and clear boundary.
B2	113–128 cm	light-yellowish-brown (2.5Y 6/3) clay; compound moderate medium to fine prismatic and fine to medium angular-blocky structure; firm to very firm when moist; few mesopores, common macropores.

This profile has an ochric epipedon and a cambic horizon.

Table 10. Analytical data of Profile 34.

Horizon	Depth (cm)	Particle-size distribution (+$CaCO_3$)			pH		$CaCO_3$eq. (%)	C (%)
		< 2μm	2–50μm	> 50μm	H_2O	$CaCl_2$		
A1	0– 22	–	–	8.4	8.02	7.31	36.27	2.24
A2	22– 50	46.5	49.9	3.6	8.16	7.44	33.16	1.45
B1	50–113	47.4	49.1	3.5	8.46	7.55	34.81	0.57
B2	113–128	47.6	50.3	2.1	8.25	7.65	40.89	0.36

Tablo 10. Profil 34'e ait analitik bilgiler.

between them could not be drawn. Both rivers are torrents but are now regulated by dams. They have long narrow valleys, cut into partly volcanic uplands and enter the Basin near the old settlements of Meram and Sille.

Near these settlements they are coarse-textured, fanning out downwards into finer textured deposits over the lacustrine marls of the Konya Area. They are bordered by saline marshes with abundant seepage. The upper part and middle of the alluvial fan are heavily irrigated.

AkA Clayey (Profile 34 and Table 10) are very deep, brown (10YR 4/3) well homogenized predominantly subangular-blocky clay-loams and clays with a structural B horizon and very weak secondary calcification. They are well drained and saltfree or slightly salt-affected, except near the lower boundary and in depressions with poor drainage which are saline. They are gently sloping and nearly level. Soil observations indicate a complex of coarser textured levees and finer textured basins, which could not be mapped because of the dense settlement. Irrigated agriculture and horticulture produces a wide variety of commercial crops.

The salt-affected parts are ranged. North-west and north-east of Konya the soil is used for brickmaking.

AkB Loamy, locally sandy are well drained saltfree loams or sands, according to the scarce survey data, otherwise similar to the AkA soils. They are well homogenized by centuries of irrigated horticulture. Locally the sands are quarried as building material. They occur east of the settlements of Meram and Sille and also in small patches mainly south of Konya, which could not be mapped separately.

Am May Fan Soils The May deposits are west of Çumra and around İçeriçumra. The river is a short torrent, now regulated by a dam. Its sediments are medium and coarse textured, often stratified and complex. It is bordered on the east by the vast Çarşamba Fan. But mineralogical studies of subsoil have revealed that the May Fan deposits underlie much of the Çarşamba Fan (de Ridder, 1965). Near İçeriçumra productive orchards are irrigated with Çarşamba water. In the north of the fan is a small area with fine-textured basin soils which have been described as Former Backswamp Soils (AbC). For details see Driessen & de Meester (1969).

AmA Loamy, locally clayey (Profile 35, Figs. 40 and 41, and Table 11) are deep, brown (10YR 4/3) loams or silt-loams with a subangular structure, well homogenized to about 100 cm and showing no pedogenesis except for pseudomycelia and powdery carbonate spots between 50–70 cm. Small hard clayballs are found throughout the profile. The parts covered by fruit and vegetable gardens have extremely porous and homogenized soils (see Fig. 83).

They are well drained, saltfree, flat and nearly level. The unit is a complex of loams and clays deposited by shifting river channels still visible locally. The boundary with the Çarşamba deposits is marked by differences in texture and colour.

Near İçeriçumra, they are under highly productive irrigated horticulture. The rest are under wheat, sugar-beet and sunflower with only supplementary irrigation in spring.

AmB Shallow loamy, locally sandy, over soft lime and limestone have calcareous layers at 50–100 cm because the May Fan Soils are deposited over remnants of terrace soils. The calcareous layer has been disturbed by homogenization. Other features are similar to AmA.

AmC Gravelly or sandy in the narrow May Valley are deep sandy or gravelly. Isolated patches also occur in the fan area, presumably indicating former channels.

An Bayat Fan Soils The Bayat deposits, from a small torrential and intermittent stream, lie about 20 km west of Bor. Few survey data are available.

AnA Clayey and loamy are moderately shallow and deep brown (10YR 4.5/3) clay-loam or loam over soft lime. They are well drained and saltfree in the upper and

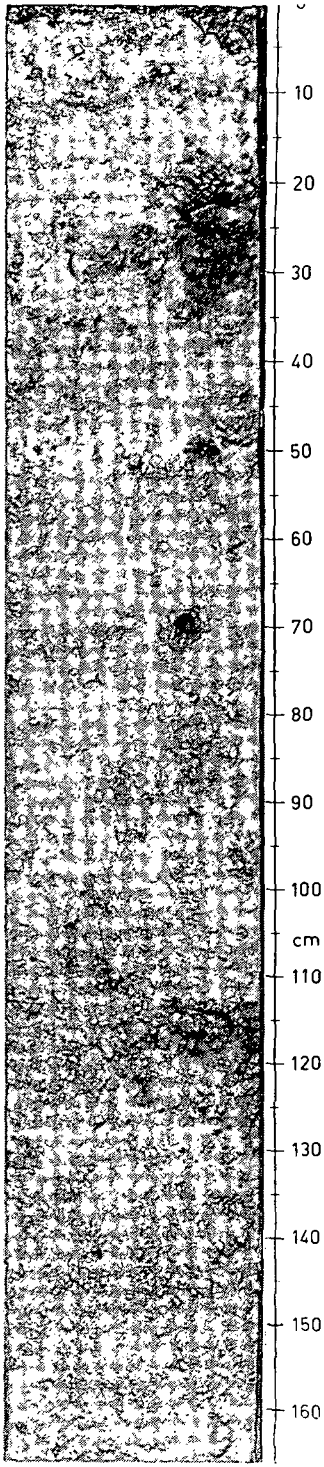


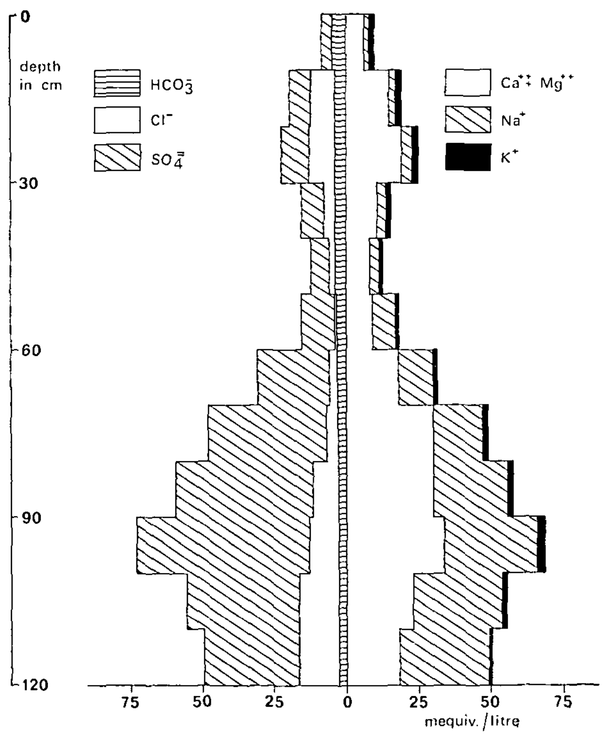
Fig. 40. Profile no 35.
Şekil 40. Profil no. 35.

AmA Loamy, locally clayey, May Fan Soils

Great Konya Basin, Çumra Area, 59.9N, 76.0E, alt. 1012 m, 2–9–1964 (de Meester, Bannink & Gülcan)

Geomorphology: alluvial fan
Parent material; calcareous clay-loam
Relief and slope: flat, nearly level
Stoniness: Class 0
Hydrology: moderately well drained, watertable about 3 m
Moistness: dry moist subsoil
Salinity: saltfree
Biology: few roots, many krotovinas and recent open animal burrows throughout profile
Land-use: dry-farming
Classification: 1964 Typic Ustochrept
1967 Typic Xerochrept

Fig. 41. Ion balance of Profile 35.



Şekil 41. Profil 35'de iyon dengesi.

Table 11. Analytical data of Profile 35.

Horizon	Depth (cm)	Particle-size distribution						$CaCO_3$eq. (%)
		< 2μm		2–50μm		> 50μm		
		$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	
Ap	5– 15	38.7	24.1	21.6	38.3	39.7	36.8	12.3
B2	40– 50	40.2	26.2	20.0	37.1	39.8	37.8	13.8
Bc	70– 80	43.2	27.8	17.2	36.9	39.6	36.5	15.5
IIBb	115–125	35.4	34.7	40.0	41.5	24.6	24.3	16.6
IIBb	145–155	52.5	38.7	22.7	39.1	24.8	25.0	15.1

Depth	pH	ECe	CEC	ESP
0– 10	7.80	0.93	19.24	0.78
10– 20	7.72	1.98	—	—
20– 30	7.70	2.37	—	—
30– 40	7.73	1.52	18.60	1.34
40– 50	7.78	1.32	—	—
50– 60	7.87	1.76	—	—
60– 70	7.85	2.91	—	—
70– 80	7.78	4.09	21.98	3.37
80– 90	7.84	4.84	—	—
90–100	7.88	5.69	—	—
100–110	7.96	5.00	—	—
110–120	8.00	4.52	22.94	11.81

Tablo 11. Profil 35'e ait analitik bilgiler.

Soil description of Profile 35.

Ap	0– 18 cm	brown to dark-brown (10YR 4/3) clay-loam, light-yellowish-brown (2.5Y 6/2) when dry; weak fine subangular-blocky with fine granular material; hard when dry, slightly sticky when wet; many macropores and mesopores; clear smooth boundary.
B2	18– 44 cm	brown to dark-brown clay-loam, light-brownish-gray (10YR 6/2) when dry; moderate medium subangular-blocky, hard when dry, slightly sticky when wet; many macropores and mesopores; common fine faint pseudomycelia; diffuse boundary.
BC	44–107 cm	similar but with common clayballs 1 cm diam. and few 3–5 cm diam. of clay-loam with moderate fine to medium angular-blocky structure and friable consistency when moist; diffuse boundary.
IIB b	107–170 cm	brown to dark-brown (10YR 4/3) loam, weak medium and fine subangular-blocky; friable when moist, slightly sticky when wet; many macropores and mesopores; common fine faint pseudo mycelia; many clayballs as in horizon BC.

This profile has an ochric epipedon and a cambic horizon.

middle part but poorly drained and saline in the lower part (near the road from Yeni-Zengen to Bor).

The unit is complex with sandy-loam in the upper part and clay-loam and clay in the lower part. Soil depth over soft lime varies in the same direction from very deep to moderately deep.

They are under wheat unless saline, when they are ranged.

As Ayran Fan Soils The Ayran deposits consist of two separate fans, the upper is halfway between Karaman and Ereğli and the lower 30 km due south of Karapınar. The river flows throughout the year and has a large discharge. It enters the plain near Ayrancı (Karaman Area east), where a large dam regulates its flow. The first fan immediately west of Ayrancı has not been surveyed but its soils are presumed to be almost similar to those of the second fan. The river traverses a limestone range north-west of Ayrancı and has deposited the second, much larger, fan north of the range around the Village of Serpec.

The soils of both fans are very complex vertically as well as horizontally.

AsA Clayey, locally complex loamy and sandy (Profile 36 and Table 12) are deep yellowish-brown (10YR 4/4.5) clay-loam or clay with a clear Ap and a structural B horizon and mainly a subangular-blocky structure. Secondary carbonate segregation is limited to very few white spots. In the lower fan they are locally very complex: loamy soils occur but also profiles stratified with loamy or sandy layers. The foot thins out over lacustrine marls. Topography is flat and nearly level. They are well drained and saltfree but heavy haphazard irrigation in summer causes flooding and local salinization. The soils of the first fan near Ayrancı have a modern irrigation system. Most grow irrigated wheat, rye and barley. Near the villages are orchards.

AsB Sandy and gravelly are deep brown sandy and gravelly soils in the valley and near the streambed at the apex of the fan. They are flat and nearly level. The unit is complex with abandoned stream channels here and there. They are mainly irrigated for horticulture.

Table 12. Analytical data of Profile 36.

Depth (cm)	pH (H_2O)	Total salt (%)	$CaCO_3$ eq. (%)	org. C (%)
0– 40	8.10	0.070	41	1.5
40– 63	8.05	0.059	40	0.0
63– 90	8.10	0.051	51	—
90–127	7.90	0.052	56	—
127–140	7.78	0.160	61	—

Tablo 12. Profil 36'ya ait analitik bilgiler.

Profile 36.
Profil 36.

AsA Clayey, locally complex loamy and sandy Ayran Fan Soils

Great Konya Basin, Karapınar Area, 51.3N, 157.2E, alt. 1005 m, 6-7-1965 (Locher)

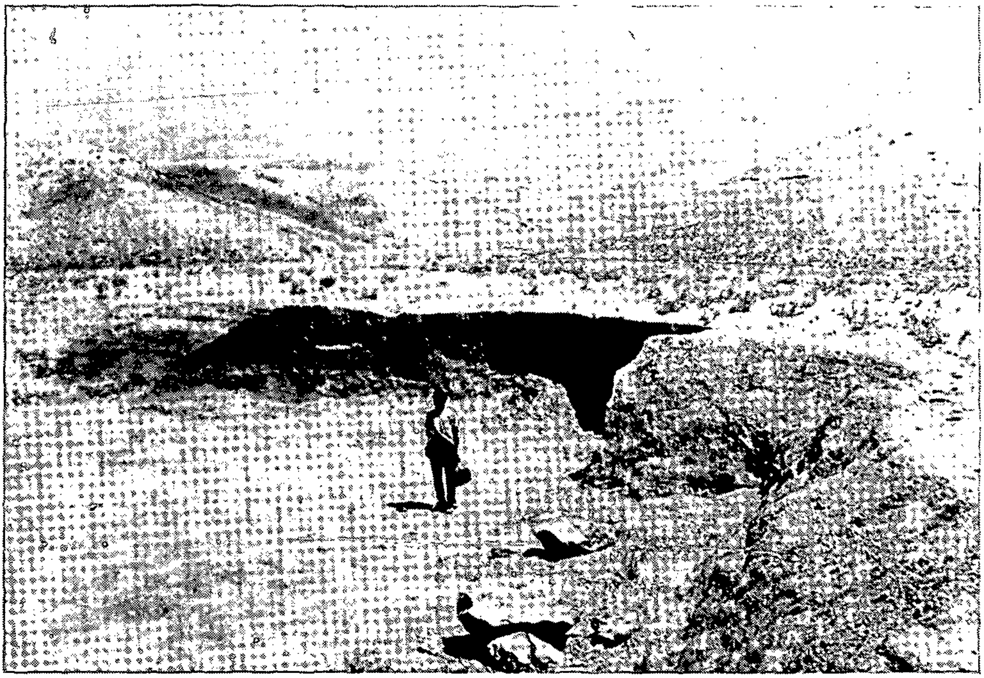
Geomorphology: alluvial fan
Parent material: calcareous loam and clay-loam
Relief and slope: flat, nearly level
Stoniness: Class 0
Hydrology: well drained, not irrigated every year, watertable 5 m
Moistness: moderately dry
Salinity: saltfree
Biology: 0-100 cm plentiful fine roots, few coarse roots; 100-140 cm few roots, some wormholes and burrows
Classification: 1964 Typic Calciorthid
1967 Typic Calciorthid

Soil description of Profile 36.

Ap	0- 20 cm	dark-yellowish-brown (10YR 4.5/4) sandy loam, light-yellowish-brown to very pale-brown (10YR 6.5/4) when dry; clods and loose structure; slightly sticky slightly plastic; very friable; slightly hard; many macropores and mesopores abrupt smooth boundary.
A1	20- 40 cm	dark-yellowish-brown (10YR 4.5/4) sandy loam, light-yellowish-brown to very pale-brown (10YR 6.5/4) when dry; moderate medium to coarse subangular-blocky; slightly sticky slightly plastic; very friable; slightly hard; many macropores and mesopores; clear smooth boundary.
B1	40- 64 cm	dark-yellowish-brown (10YR 4.5/4) sandy loam, light-yellowish-brown to very pale-brown (10YR 6.5/4) when dry; moderate medium subangular-blocky; slightly sticky slightly plastic; very friable; slightly hard; many macropores and mesopores; few medium distinct calcareous mottles; clear smooth boundary.
B2ca	64- 90 cm	light-yellowish-brown (10YR 6/4) loam, very pale-brown (10YR 7/3) when dry; moderate medium angular-blocky; slightly sticky slightly plastic; very friable; hard; common macropores and few mesopores; few medium distinct calcareous mottles; soil pipes ø 5 to 10 mm; clear, smooth boundary.
B3ca	90-127 cm	light-yellowish-brown (10YR 6/4) clay-loam, very pale-brown (10YR 7/4) when dry; moderate medium (sub)angular-blocky; slightly sticky, slightly plastic; friable; hard; common macropores and few mesopores; few medium distinct calcareous mottles; clear smooth boundary.
C ca	127-140 cm	light-yellowish-brown (10YR 6/4) coarse sand, very pale-brown (10YR 7/4) when dry; weak coarse subangular blocky; non-sticky, non-plastic, loose, hard; common macropores and few mesopores; few medium distinct calcareous mottles.

This profile has an ochric epipedon, a cambic horizon and a calcic horizon.

Fig. 42. Gravel quarry in Medium-sized gravelly Alluvial Fan (AuB), northeast of Karakaya, Konya Area. The fan has been deposited from the valley running towards the right background in the Limestone Uplands (UrA).



Şekil 42. Konya bölgesinde, Karakaya'nın doğusunda Orta-büyüklükte çakıllı Alluviyal yelpaze (AuB) içinde çakıl ocağı. Yelpaze sağ arka plâna doğru uzanan kireç taşı yüksek arazilerindeki (UrA) vadiden getirilerek yığılmıştır.

Au Soils of Medium-Sized Fans (Fig. 42). At about 28 places around the Basin, small seasonal rivers and large gullies enter the plain, forming small cones or fans of mainly coarse-textured material. They are often transitional between the upper part of Bajadas and Alluvial Fans. Their soils vary in characteristics according to position and size of fan; each fan is itself a soil complex. Texture at the apex is coarser than in lower parts. Map units will not be further described but the lower parts have been grouped into three units:

AuA Clayey and loamy
AuB Gravelly and sandy
AuC Volcanic angular-cobbly

5.7 L **Lacustrine Plains** (Fig. 43)

During the Pleistocene period, a large shallow lake covered the centre of the Basin. It gradually dried up and most of its floor has remained free of later sediments, giving rise to a vast extremely flat and level plain. All soils arising from deposits in the ancient lake or by the action of the lake are included in Lacustrine Plains.

They consist of five slight depressions of carbonatic clays, here called Marl Soils (Lm), separated by low ridges of lacustrine sand, called Sandridge Soils (Lr) deposited originally as coastal sediments, but now reworked by wind and water. Some areas even contain extremely calcareous Sand Dunes (Dd).

The Lacustrine Plains are studied in detail by de Meester, (1971).

The Lacustrine Plains consist of 4 associations and 14 units.

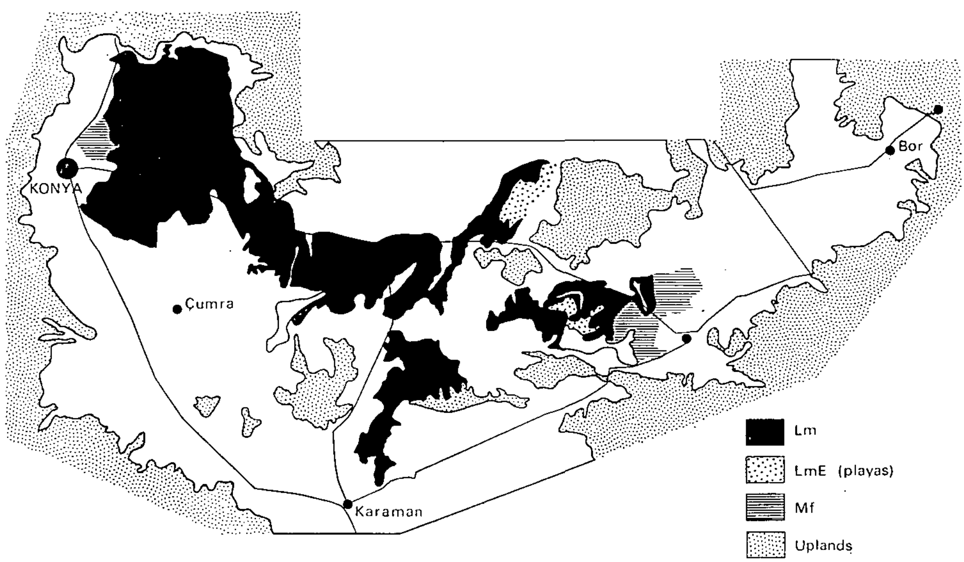
Lm Marl Soils

LmA Clayey, with shell fragments
LmB Often stratified loamy, with shell fragments
LmC Clayey with shell fragments, shallow dark-gray organic surface soil
LmD Predominantly salt-affected pale clayey
LmE Strongly salt-affected clayey, periodically flooded playa
LmF Hydromorphic, locally gypsiferous and cemented, clayey

Lr Sandridge Soils

LrA High
LrB Low

Fig. 43. Distribution of Marl Soils (Lm), Playas (LmE) and Marshes (Mf).



Şekil 43. Marn topraklarının (Lm), playaların (LmE) ve bataklıkların (Mf) dağılışları.

Lp Sandplain and Beach Soils
- LpA Dark-grayish-brown
- LpB Pale-brown stratified carbonatic, with shell fragments
- LpC. Carbonatic, with dark volcanic surface
- LpD Reworked, complex stratified

Lo Old Sandplain Soils
- LoA Undulating deep
- LoB Nearly flat shallow, over terrace

Lm Marl Soils Most of the Lacustrine Plains is occupied by unconsolidated lacustrine sediments. These soils contain 45–60% magnesium and calcium carbonates. Part of this carbonate must have precipitated in the lake during the silting up. It was mixed with other calcareous and non-calcareous sediments by turbulence. We have called these soils with such an unusually high carbonate content 'marls'. The 1967 Supplement of the 7th Approximation (Soil classification, 1964) classes them at family level as 'fine carbonatic' or 'carbonatic'. The deeper layers of this marl are stratified with sand and shell fragments, mainly *Dreissenia* spp. Very few shells are entire, both indicating turbulence in the ancient lake. Locally the marls are loamy or fine sandy (LmB) and the lowest parts (LmC) are dark because of continuous marshy conditions. Large areas are salt-affected or poorly drained. Where salinization has modified the profile, special units have been introduced: LmD for those with an internal salic horizon and LmE for those with a continuous saltcrust. Others which are saline are indicated on the map by symbols only (Fig. 44).

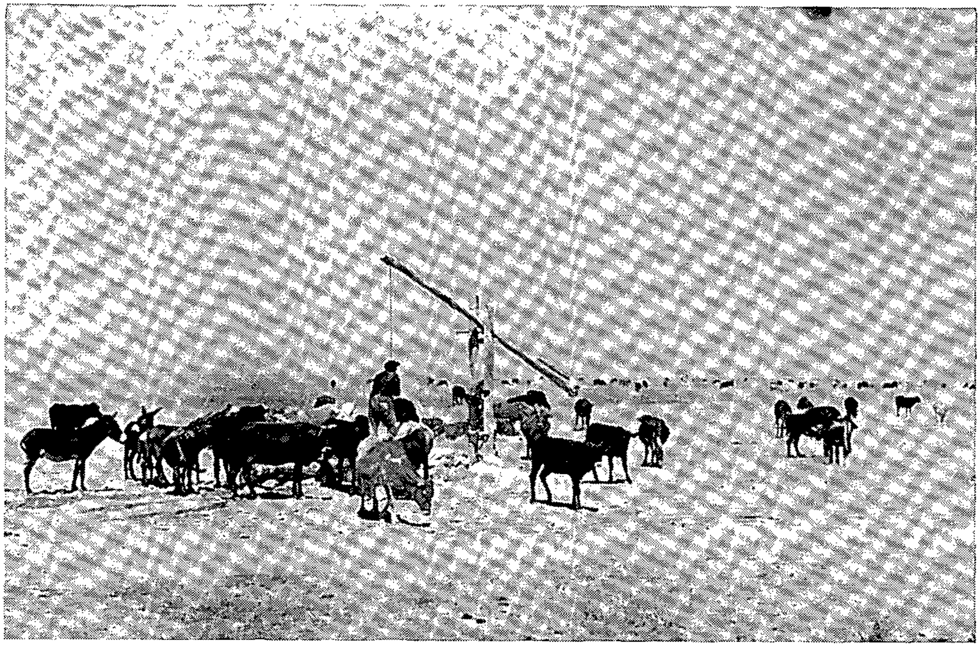
LmA Clayey, with shell fragments (Figs. 45, 46 and 47, Profiles 37 and 38 and Tables 13 and 14) are deep, olive-gray (2.5Y 6/2) carbonatic (heavy) clays, containing small shell fragments with subangular-blocky surface soil and fine-prismatic subsoil. They have a clear Al, a structural B, a calcic and often a gypsic horizon. The subsoil may contain layers of shells or fragments. Yellow mottling is characteristic. They are moderately well drained, locally moderately internally salt-affected, flat and level.

The unit is uniform, varying only locally in depth of A1 horizon and salinity. East of Hotamış they occur with at most a very thin A1 horizon. They are partly under dry wheat, partly range. Several areas are irrigated from pump wells. See Figs. 78 and 79.

LmB Often stratified loamy with shell fragments (Figs. 49 and 48, Profile 39 and Table 15) are very deep, dark-grayish-brown (2.5Y 4/2), mainly subangular-blocky medium-textured soils with a weak calcic and sometimes a gypsic horizon. They are well drained, saltfree or slightly salt-affected, flat and nearly level. The unit is complex with much stratification of sandy layers which changes over short distances. They commonly have a dark organic layer at 50–100 cm. The largest patch is around Demirkent (Çumra and Hotamış Areas) where sandy ridges cross the unit. They are mainly under dry wheat.

LmC Clayey with shell fragments, shallow dark-gray organic surface soil (Fig. 50, Profile 40 and Table 16) are similar to LmA except that the top 30–50 cm is dark-gray

Fig. 44. Marl Soils. Above: moderately salt-affected (LmF) and used as poor rangeland near Taşağıl, Çumra Area. Below: slightly salt-affected (LmA) and used for wheat cultivation near Ortakonak, Konya Area.



Şekil 44. A orta derecede tuz etkisinde kalmış (LmF) ve kısır arazi olaralk kullanılmış ve B hafif tuz etkisinde kalmış (LmA) ve buğday tarlası olarak kullanılmış, marnlı topraklar.

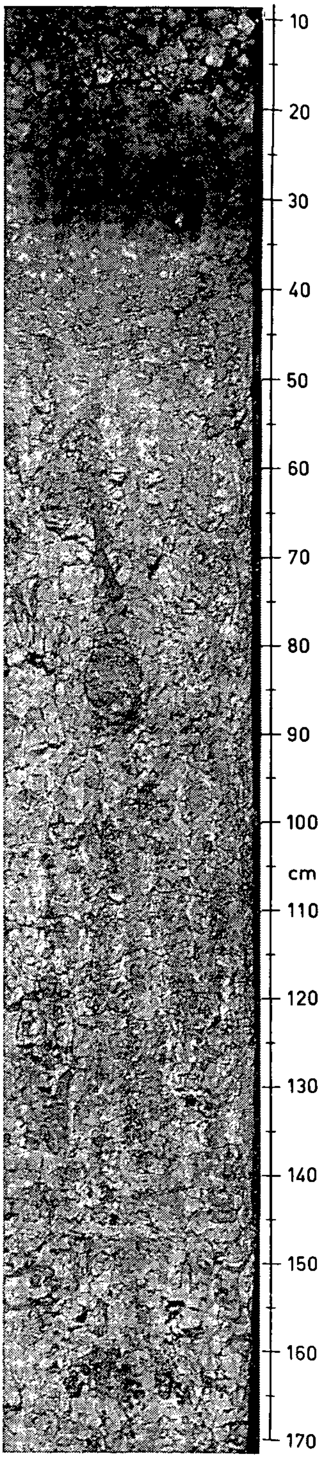


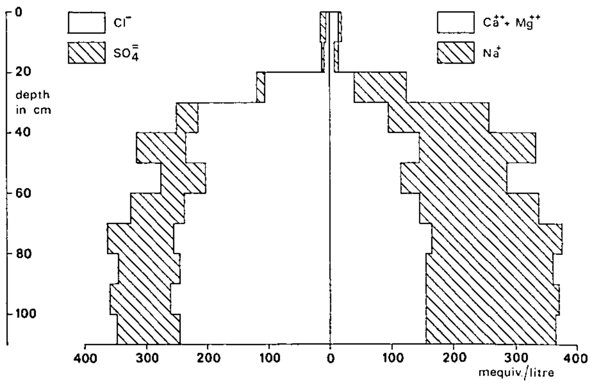
Fig. 45. Profile no 37.
Şekil 45. Profil no. 37.

LmA Clayey Marl Soils with shell fragments

Great Konya Basin, Konya Area, 104.0N, 75.0E, alt. 1001 m, 20–9–1965 (Locher)

Geomorphology: lacustrine marl plain
Parent material: highly calcareous silty clay and clay
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: moderately well drained, watertable 2 m
Moistness: dry
Salinity: slightly salt-affected
Biology: 0–14 cm abundant fine roots, 14–30 cm plentiful roots, 30–180 cm few roots
Land-use: dry-farming, fallow
Classification: 1964 Aquic Calciorthid
1967 Aquic Calciorthid

Fig. 46. Ion balance Profile no 37.



Şekil 46. Profil 37'de iyon dengesi.

Table 13. Analytical data of Profile 37.

Horizon	Depth (cm)	Particle-size distribution ($-CaCO_3$)			$CaCO_3$eq. (%)	org. C (%)	N (%)	C/N
		< 2μm	2–50μm	> 50μm				
Ap	0– 20	–	–	–	48.6	1.21	0.06	20.1
A11	20– 32	44.3	43.7	12.0	62.8	0.00	–	–
A12ca	32– 40	54.9	37.6	7.5	75.5	–	–	–
B1ca	40– 58	55.7	40.4	3.9	73.8	–	–	–
B2ca	58–102	55.4	43.2	1.4	64.7	–	–	–
C1	102–147	56.1	41.0	2.9	55.1	–	–	–
C2	147–172	50.7	47.8	1.5	54.7	–	–	–

Tablo 13. Profil 37'ye ait analitik bilgiler.

Soil description of Profile 37.

Ap 0– 20 cm light-gray (5Y 6.5/1) when dry silt-loam; clods with weak fine granular structure; abrupt smooth boundary.

A11 20– 32 cm light-olive-gray (5Y 5.5/2) silt-loam, light-gray (5Y 6.5/1) when dry; weak very fine granular; hard when dry, very friable when moist, slightly sticky non-plastic when wet; many macropores and mesopores; few shell fragments; clear smooth boundary.

A12ca 32– 40 cm light-olive-gray (5Y 5.5/2) silty clay-loam, (light-)gray (5Y 6.5/1) when dry; massive; hard when dry, very friable when moist, slightly sticky non-plastic when wet; many macropores and mesopores; few shell fragments; clear smooth boundary.

B1ca 40– 58 cm grayish-brown to light-grayish-brown (2.5Y 5.5/2) silty clay, light-gray to white (2.5Y 7.5/2) when dry; compound moderate medium platy and moderate fine subangular-blocky; hard when dry, very friable when moist, slightly sticky non-plastic when wet; many macropores and mesopores; wavy boundary.

B2ca 58–102 cm pale-olive to pale-yellow (5Y 6.5/3) calcareous clay, white (5Y 8/2) when dry; compound weak medium prismatic and medium angular-blocky; hard when dry, friable when moist, slightly sticky and plastic when wet; common macropores and few mesopores; common fine distinct brownish-yellow (10YR 6/6) rust mottles; clear wavy boundary.

C1 102–147 cm light-olive-gray to light-gray (5Y 6.5/2) clay, light-gray to white (5Y 7.5/2) when dry; compound moderate medium platy and fine angular-blocky; hard when dry, friable when moist, slightly sticky, plastic when wet; few macropores and very few mesopores; many light-olive-brown (2.5Y 5/6) coarse prominent rust mottles; few powdery gypsum veins; common tiny manganese spots on ped surfaces; abrupt smooth boundary.

C2 147–172 cm light-olive-gray (5Y 6/2) clay, light-gray to white (5Y 7.5/2) when dry; compound moderate very thick platy and coarse angular-blocky; hard when dry, friable when moist, slightly sticky, plastic when wet; few macropores and very few mesopores; many prominent rust mottles; few powdery gypsum veins; common tiny manganese spots on ped surfaces.

This profile has an ochric epipedon, a cambic and a calcic horizon.

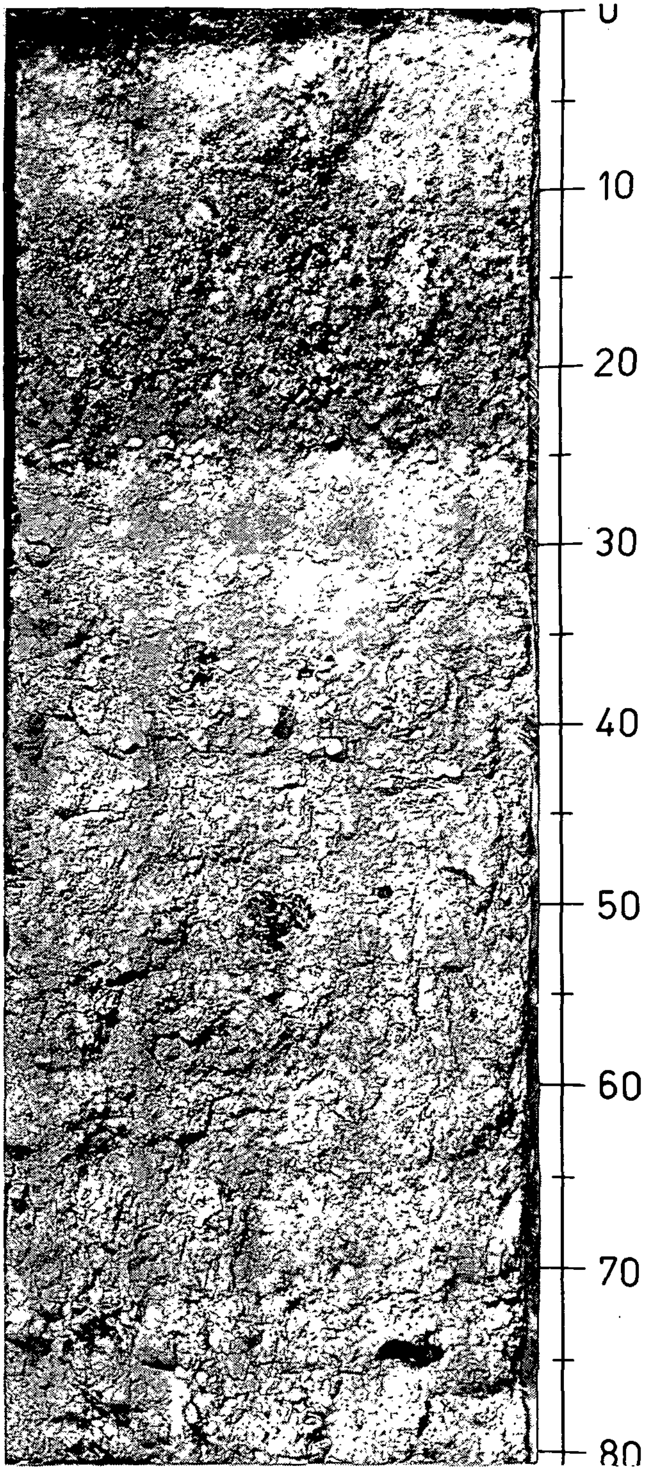


Fig. 47. Profile no 38.
Şekil 47. Profil no. 38.

LmA Clayey Marl Soils with shell fragments

Great Konya Basin, Hotamış Area, 74.5N, 132.2E, alt. about 1003 m, 29-7-1968 (van den Eelaart, de Meester)

Geomorphology: lacustrine marl plain
Parent material: highly calcareous silt-clay
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: drained, water-table 5 m
Moistness: slightly moist to almost dry
Salinity: slightly salt-affected
Biology: disturbed subsoil, surface soil much biological activity, common krotovinas and common biopores to 100 cm
Land-use: dry-farming, wheat, fallow for two months
Classification: 1964 Aquic Calciorthid
1967 Aquic Calciorthid

Table 14. Analytical data of Profile 38.

Horizon	Depth (cm)	Particle-size distribution			pH		$CaCO_3$eq. (%)	C (%)	CEC
		< 2μm	2–50μm	> 50μm	H_2O	$CaCl_2$			
Ap	0– 12	25.8	53.6	20.7	7.35	6.85	47.3	1.17	17.5
A1	12– 23	34.1	46.8	17.0	7.00	6.95	49.3	1.04	19.4
B21ca	23– 53	49.2	43.4	7.0	7.35	7.35	59.6	0.71	19.8
B22	53– 87	46.3	48.4	3.9	7.60	7.65	54.7	0.00	19.8
C1cs	87–100	46.6	46.3	3.5	7.70	7.70	53.8	—	19.4
C2cs	100–130	53.6	43.2	1.8	7.00	7.70	56.8	—	18.0

Tablo 14. Profil 38'e ait analitik bilgiler.

Soil description of Profile 38.

Ap 0– 12 cm grayish-brown (2.5Y 5/2) loam; strong very thick microporous platy blocky structure with rounded edges; slightly sticky slightly plastic, friable slightly hard; abrupt smooth boundary.

A1 12– 23 cm grayish-brown (2.5Y 5/2) loam; moderately strong fine mesoporous crumby structure; slightly stickly slightly plastic; very friable soft; many cocoons filled with clay; clear smooth boundary.

B21ca 23– 53 cm light-brownish-gray (2.5Y 6/2) silty clay; moderately weak medium macroporous regular subangular blocky structure; sticky plastic friable slightly hard; many coarse clear light-gray (2.5Y 7/2 when moist) calcareous concretions, hard when dry; evenly enriched with carbonates; clear smooth boundary.

B22 53– 87 cm grayish-brown (2.5Y 5/2) silty clay; moderate fine macroporous roughly compound prismatic structure, consisting of strong fine macroporous regular angular-blocky structure with rootprints and very thin illuvial skins on peds; sticky plastic friable slightly hard; some extremely hard calcareous concretions; clear smooth boundary.

C1cs 87–100 cm light-brownish-gray (2.5Y 6/2) carbonatic silty clay; moderately strong medium macroporous regular angular-blocky structure with rootprints but no skins on peds; sticky plastic friable slightly hard; abundant gypsum veins; clear smooth boundary.

C2cs 100–> 130 cm light-gray (2.5Y 7/2) silty clay; moderately weak medium macroporous regular-blocky structure with rootprints but no skins on the peds; sticky and plastic; firm and hard; many gypsum veins few clear fine rust mottles; reddish-yellow (5YR 6/6) fine magnesium mottles; many shell fragments.

This profile has an ochric epipedon, a cambic and a calcic horizon.

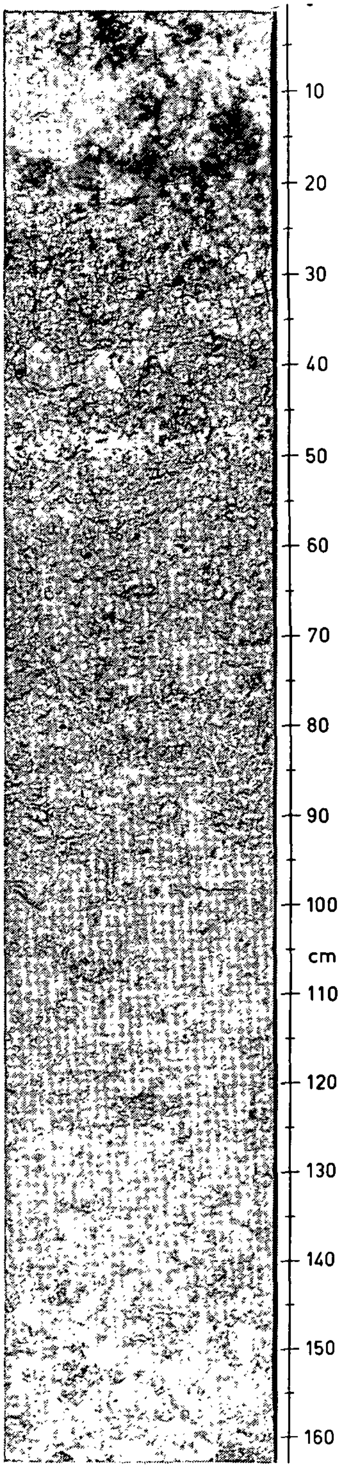


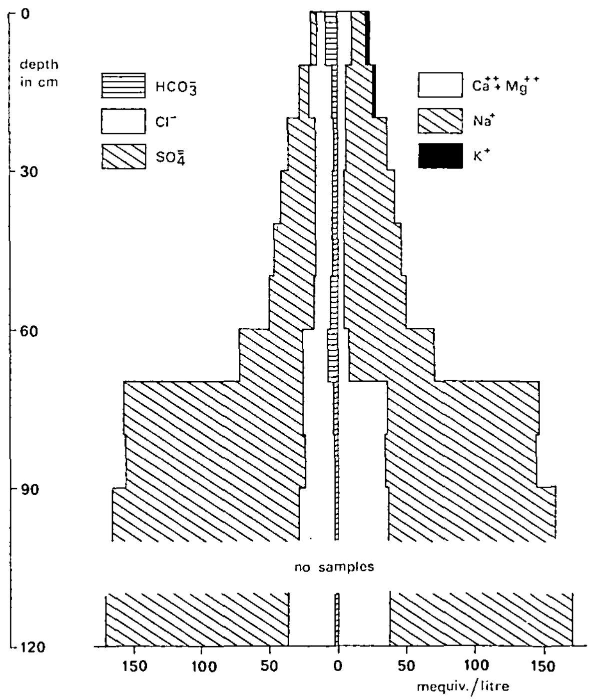
Fig. 48. Profile no 39.
Şekil 48. Profil no. 39.

LmB Often stratified loamy Marl Soils with shell fragments

Great Konya Basin, Çumra Area, 73.4N, 103.1E, alt. 1001 m, 24–9–1964 (de Meester & van Blom)

Geomorphology: lacustrine plain
Parent material: calcareous silt-loam
Relief and slope: flat, nearly level
Stoniness: Class 0
Hydrology: moderately well drained, watertable about 4 m
Moistness: 0–104 cm dry, 104–160 cm moist
Salinity: slightly to moderately salt-affected (saline-alkali)
Biology: common roots in top 50 cm, few krotovinas
Land-use: dry-farming, fallow
Classification: 1964 Salic Calciorthid
1967 Salic Calciorthid

Fig. 49. Ion balance Profile no 39.



Şekil 49. Profil no. 39'da iyon dengesi.

(10Y 4/1) because of high content of organic carbon resulting from former marshy conditions. Recently reclaimed parts have the remains of roots throughout the profile.

They lie in the lowest parts of the Basin, where drainage conditions are poor and are usually moderately salt-affected unless irrigation is applied. They are flat and level. The unit is uniform except in salinity and depth of the dark surface soil, which varies between 30 and 60 cm. They occur mainly in the centre of the Konya and Hotamış areas. Locally they merge into Backswamp Soils (AbC). They are under dry wheat or, if saline, range. A large area between Yarma and Karakaya is irrigated and yields well.

LmD Predominantly salt-affected pale clayey (Fig. 51, Profile 41) are deep, olive-gray (2.5Y 6/1) angular-blocky or prismatic clays whithout distinct horizons except a salic horizon. They are poorly drained, always strongly salt-affected with patches of external solonchak, and flat and level. They occur west of Ortakonak (Konya Area), north of Karapınar and north of Ak Göl (Karapınar and Ereğli areas).

The vegetation is Halophytic so they are either poor range or barren land.

LmE Strongly salt-affected clayey periodically flooded playa are deep white (2.5Y 6/0) moist clays with reduced hydromorphic surface soil entirely covered with a saltcrust. They are playas, poorly drained in summer, flooded for at least half of the

Soil description of Profile 39.

Ap	0– 19 cm	grayish-brown (2.5Y 4.5/2) silt-loam, light-brownish-gray (2.5Y 6/2) when dry; moderately fine platy structure; slightly hard when dry, sticky plastic when wet; common mesopores and macropores; clear smooth boundary.
B2.1 ca	19– 56 cm	dark-grayish-brown (2.5Y 4/2) silt-loam; grayish-brown when dry (2.5Y 5/2); common calcareous spots, white (2.5Y 8/2) moist and dry; moderate medium compound prismatic structure; slightly hard when dry, sticky plastic when wet, gradual smooth boundary.
B2.2	56– 75 cm	brown (10YR 5/3) silt-loam, very-pale brown (10YR 8/3) when dry; structure alike B21 no calcareous spots; common medium distinct rust mottles (10YR 6/6); abrupt smooth boundary.
B3 cs	75– 84 cm	grayish-brown (2.5Y 5/2) silt; weak medium subangular-blocky, light-gray (2.5Y 6.5/2) when dry; slightly hard when dry, sticky plastic when wet; common macropores and mesopores; abundant gypsum veins and common medium distinct rust mottles; gradual wavy boundary.
C1 cs	84–104 cm	similar but less gypsum veins.
C2 cs	104–120 cm	grayish-brown to light-brownish-gray (2.5Y 5.5/2) silt-loam with fine alternating layers of very fine sand, light-gray (2.5Y 7/2) weak medium subangular-blocky structure; common gypsum veins and crystals; few medium distinct rust mottles; gradual smooth boundary.
C 3	120–140 cm	similar but silt-loam not stratified; no rust, no gypsum veins; many medium crystal clusters of gypsum; gradual wavy boundary.
(II) C4 cs	140–162 cm	pale-brown (10YR 6/3) silty clay-loam, very pale-brown (10YR 8/3) when dry; strong medium angular-blocky; friable when moist, sticky plastic when wet; few macropores and mesopores; very many clusters of gypsum crystals; few fine manganese concretions.

This profile has an ochric epipedon, a cambic, a calcic and a gypsic horizon.

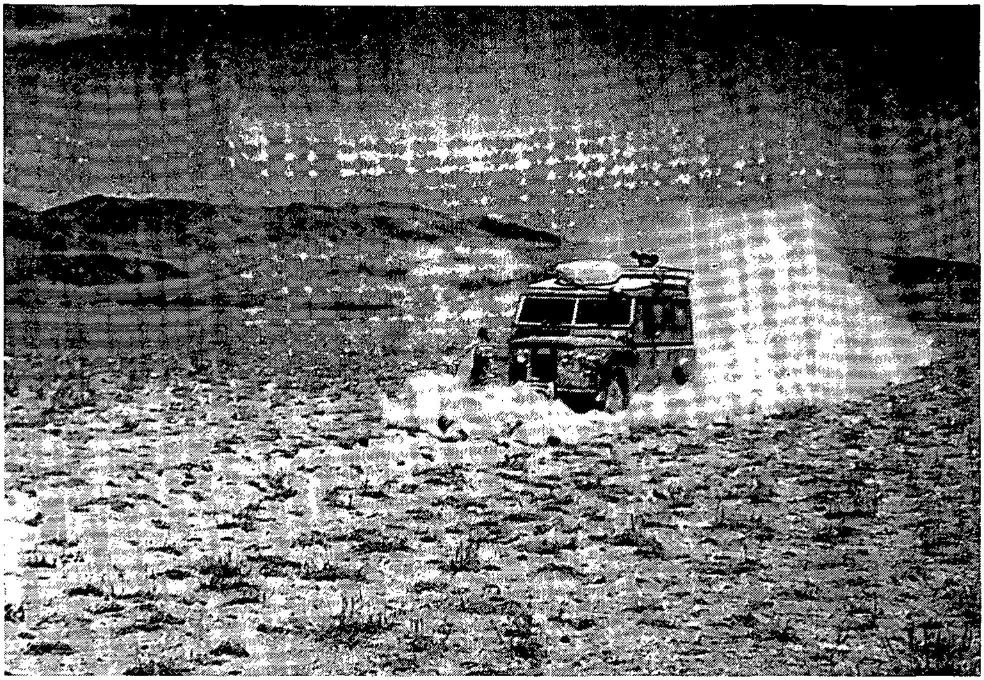
Table 15. Analytical data of Profile 39.

Horizon	Depth (cm)	Particle-size distribution $< 2\mu m$ $-CaCO_3$	$< 2\mu m$ $+CaCO_3$	$2\text{–}50\mu m$ $-CaCO_3$	$2\text{–}50\mu m$ $+CaCO_3$	$> 50\mu m$ $-CaCO_3$	$> 50\mu m$ $+CaCO_3$
Ap	5– 15	34.7	17.8	47.7	59.4	15.6	22.8
B22	55– 65	41.4	–	50.2	–	8.3	–
C1cs	90–100	45.1	–	39.9	–	15.0	–
C3cs	125–130	30.7	27.2	44.6	43.9	24.7	28.9
(II)C4cs	150–160	63.9	–	28.4	–	7.4	–

Depth	pH	ECe	CEC	ESP	$CaCO_3$eq.	Depth	pH	ECe	CEC	ESP	$CaCO_3$eq.
0–10	7.60	2.35	17.31	6.64	24.7	70– 80	7.91	12.05	15.42	31.58	30.0
10–20	7.70	2.82	–	–	29.3	80– 90	7.95	12.05	–	–	35.9
20–30	8.01	3.78	–	–	48.8	90–100	7.91	12.86	–	–	33.7
30–40	8.26	4.19	14.98	28.97	43.4	100–110	–	–	–	–	–
40–50	8.46	4.47	–	–	47.2	110–120	7.92	13.19	11.14	5.48	33.3
50–60	8.41	5.03	–	–	40.2	120–130	–	–	–	–	–
60–70	8.23	6.79	–	–	31.2	130–140	7.90	15.30	–	–	35.4

Tablo 15. Profil 39'a ait analitik bilgiler.

Fig. 51. Fieldparty traversing salt-affected Marl Soil (LmD), Karapınar Area east. Land-use is very poor rangeland (mainly *Halocnemum*). In background Volcanic Uplands (UvA) with Volcanic Bajadas (BvB and BvC) at their foot.



Şekil 51. Karapınar bölgesinin doğusunda arazi ekibi tuz etkisinde kalmış Marn Toprak'ta (LmD) travers çiziyor. Arazi kullanması çok zayıftır (Genellikle *Halocnemum spp.*). Arka plânda Volkanik yüksek araziler (UvA) ve onların tabanlarında Volkanik Bajadalar (BvB ve BvC).

year. They are flat and level. The soil surface is locally cracked, hard, fluffy or puffed, typical for an external solonchak. They are barren or have only isolated tufts of vegetation and are not used for agriculture. Details of salinity will be given in Driessen (1970).

LmF Hydromorphic locally gypsiferous and cemented, clayey (Profile 42 and Table 17) are deep, olive-gray (2.5Y 6/2) hydromorphic clays with reduction colours and many salt and gypsum crystals, and locally cemented layers and layers of loose shells. They are moderately well drained, moderately to strongly salt-affected, flat and level. They occur in the south-east of the Çumra Area near Taşağıl. This area was until about 15 years ago permanently flooded and belongs to the basin of the Hotamış Gölü. Remnants of roots of marsh vegetation are found throughout the profile. They form poor range.

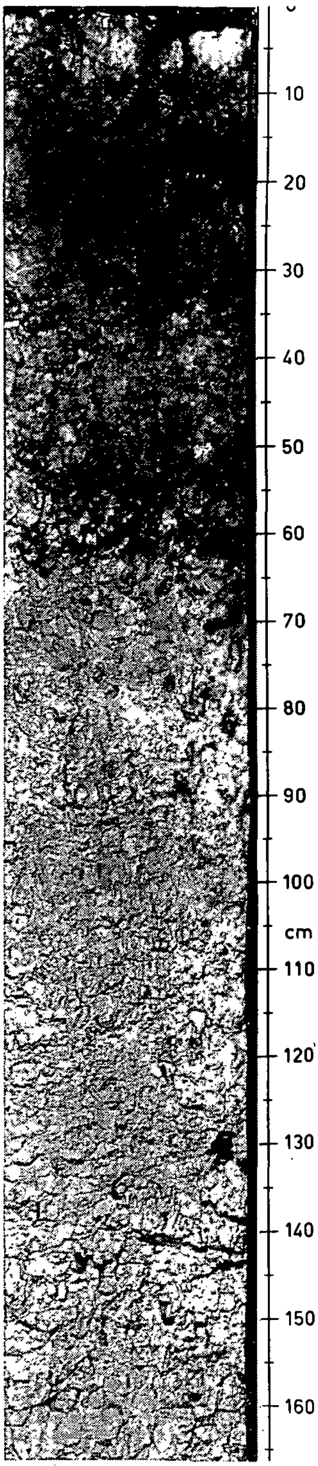


Fig. 50. Profile no 40.
Şekil 50. Profil no. 40.

LmC Clayey Marl Soils with shell fragments, shallow dark-gray organic surface soil

Great Konya Basin, Hotamış Area, 68.4N, 127.9E, alt. about 1000 m, 21–7–1965 (Peters & Winkelmolen)

Geomorphology: lacustrine plain
Parent material: highly calcareous silty clay
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: well drained, watertable deeper than 10 m
Moistness: almost dry
Salinity: saltfree
Biology: moderately rooted
Land-use: dry-farming
Classification: 1964 Aquic Calciorthid
1967 Aquic Calciorthid

Table 16. Analytical data of Profile 40

Horizon	Depth	Particle-size distribution ($-CaCO_3$)		
		< 2μm	2–50μm	> 50μm
B1	58– 95	63.9	34.2	1.9
B22g	116–150	66.9	31.4	1.7

Depth	pH	ECe	Depth	pH	ECe
0–10	7.90	0.72	60– 70	7.82	1.60
10–20	7.70	0.94	70– 80	7.72	1.60
20–30	7.85	2.60	80– 90	7.72	1.52
30–40	7.30	2.70	90–100	7.83	1.34
40–50	8.05	0.96	100–110	8.00	1.00
50–60	7.96	1.22	110–120	7.80	0.84

Tablo 16. Profil 40'a ait analitik bilgiler.

Soil description of Profile 40.

Ap 0– 10 cm dark-gray (5Y 4/1) silty clay, light-gray (5Y 7/1) when dry; moderate fine platy structure; slightly hard when dry, very friable when moist, slightly sticky non-plastic when wet; few macropores, common mesopores; many shells; abrupt smooth boundary.

A1 10– 58 cm dark-gray (5Y 4/1) silty clay, light-gray (5Y 7/1) when dry; moderate fine sub-angular-blocky; very hard when dry, very friable when moist, slightly sticky and non-plastic when wet; common macropores and mesopores; many shells; clear wavy boundary.

B1ca 58– 95 cm olive-gray (5Y 5/2) silty clay, gray (5Y 6/1) when dry; strong fine angular-blocky structure; very hard when dry, very friable when moist, sticky non-plastic when wet; few macropores and mesopores; clay coatings; many shells; clear wavy boundary.

B21 95–116 cm light-olive-gray (5Y 6/2) silty clay, light-gray (5Y 7/2) when dry; strong medium angular-blocky structure; very hard when dry, friable when moist, sticky non-plastic when wet; few macropores and mesopores; shells; clear wavy boundary.

B22g 116–150 cm light-olive-gray to gray (5Y 6.5/2) silty clay, light-gray (5Y 7/1) when dry; strong coarse angular-blocky structure; very hard when dry; firm when moist, sticky slightly plastic when wet; few macropores and mesopores; many distinct medium rust mottles; clay coatings, shells.

This profile has an ochric epipedon, a cambic and a calcic horizon.

Profile 41.
Profil 41.

LmD Predominantly pale clayey Marl Soils

Great Konya Basin, Karapınar Area east, 62.0N, 167.5E, alt. 1000 m, 15–6–1965 (Locher)

Geomorphology: lacustrine marl plain, playa
Parent material: highly calcareous clay
Relief and slope: flat, level, some shallow gullies
Stoniness: Class 0
Hydrology: poorly drained, watertable 180 cm
Moistness: dry
Salinity: strongly salt-affected
Biology: burrow of 10 cm diam. at 40 cm, very few roots
Land-use: useless, scattered salt vegetation.
Classification: 1964 Natrargid
1967 Aquic Natrargid

Soil description of Profile 41.

A	0– 36 cm	light-olive-gray (5Y 6.5/2) clay, light gray to white when dry; 0–5 cm moderate thin platy, 5–25 moderate medium angular-blocky, 25–36 strong fine angular-blocky structure. Slightly sticky non-plastic, friable, hard; common macropores and mesopores; some shells; clear smooth boundary at 25 cm and abrupt smooth boundary at 36 cm.
B21	36– 68 cm	light-gray (5Y 7/2) clay, white (5Y 8/1) when dry; compound moderate very coarse (20 cm high and 5 to 10 cm wide) prisimatic and moderate thick to very thick platy; slightly sticky non-plastic friable very hard; few macropores and mesopores; dark spots on ped surfaces; few shells; abrupt smooth boundary.
B22	68–100 cm	light-gray (5Y 7/2) clay, light-gray (2.5Y 7/0) when dry; strong very coarse prismatic structure (prisms 20 to 30 cm high and 3 to 20 cm wide); slightly sticky non-plastic friable very hard; abrupt smooth boundary.
C1	100–148 cm	light-gray (5Y 7/2) clay, light-gray (2.5Y 7/0) when dry; compound weak very fine subangular-blocky and weak very fine granular; slightly sticky non-plastic friable hard; 100–103 cm many complete shells, 103–148 cm; abrupt smooth boundary.
C2	148–180 cm	light-olive-gray to pale-olive (5Y 6/2.3) loamy sand; non-sticky non-plastic loose when moist; many shell fragments; abrupt smooth boundary.
C3	180–300 cm	light-gray (5Y 7/2) clay.

This profile has an ochric epipedon and a natric horizon.

Profile 42.
Profil 42.

LmF Hydromorhic locally gypsiferous and cemented clayey Marl Soils

Great Konya Basin, Çumra Area, 54.6N, 96.5E, alt. about 1008 m, August 1965 (Peters)

Geomorphology: lacustrine marl plain (recently dry)
Parent material: gypsiferous highly calcareous clay-loam
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: moderately well drained, watertable at 150 cm
Moistness: moist
Salinity: moderately salt-affected

Biology: 0–20 cm plentiful roots, 20–90 cm moderately rooted, deeper few roots, krotovinas between 60–90 cm

Land-use: ranging

Classification: 1964 Salic Calciorthid
1967 Salic Calciorthid

Soil description of Profile 42.

Ap	0– 22 cm	grayish-brown (10YR 5/2) clay-loam, light-gray (10YR 7/1) when dry; weak fine subangular-blocky structure; soft when dry, very friable when moist, slightly sticky non-plastic when wet; few macropores, common mesopores; abrupt smooth boundary.
A1	22– 41 cm	light-brownish-gray (2.4Y 6/2) silty-clay, light-gray (2.5Y 7/2) when dry; moderate medium subangular-blocky structure; slightly hard when dry, very friable when moist, sticky, slightly plastic when wet; few macropores, common mesopores; gradual, smooth boundary.
ACca	41– 57 cm	light-gray (2.5Y 6/2) silty clay, light-gray (2.5Y 7/2) when dry; weak compound prismatic medium subangular-blocky structure; slightly hard when dry, very friable when moist, sticky non-plastic when wet; common macropores and mesopores; few distinct calcareous veins; few small calcareous concretions; gradual smooth boundary.
C1csca	57– 90 cm	light-brownish-gray (2.5Y 6/2) silty clay, light-gray (2.5Y 7/2) when dry; moderate medium angular-blocky structure; slightly sticky, plastic when wet; common macropores, few mesopores; many prominent medium calcareous and gypsiferous mottles; large soft calcareous concretions; abrupt smooth boundary.
C2csca	90–130 cm	grayish-brown (2.5Y 5/2) silty clay, brownish-gray (2.5Y 6/2) when dry; moderate fine angular-blocky structure; slightly hard when dry, firm when moist, slightly sticky, plastic when wet; common macropores and mesopores; many prominent medium calcareous and gypsiferous mottles; many large platy gypsum crystals.

This profile has an ochric epipedon and a gypsic horizon.

Table 17. Analytical data of Profile 42

Depth	Particle-size distribution ($-CaCO_3$)		
	< 2 μm	2–50 μm	> 50 μm
41– 53	33.1	56.5	23.4
95–130	56.4	13.8	29.8

Depth	pH	ECe	$CaCO_3$ eq.
0– 22	7.30	5.5	46.7
22– 41	7.29	10.5	45.7
41– 57	7.05	10.7	39.4
57– 90	7.10	10.7	28.2
90–130	7.01	12.0	35.2

Tablo 17. Profil 42'ye ait analitik bilgiler.

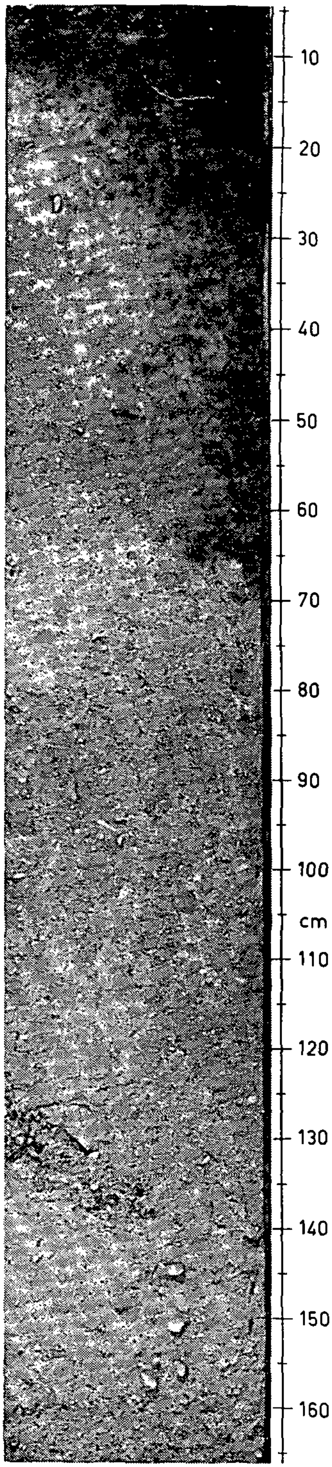


Fig. 52. Profile no 43.
Şekil 52. Profil no. 43.

LrA High Ridge Soils

Great Konya Basin, Çumra Area, 63.8N, 89.8E, alt. about 1007 m, 4–6–1964 (van Blom)

Geomorphology: former barrier beach ridge
Parent material: calcareous sand
Relief and slope: flat, nearly level
Stoniness: Class 0
Hydrology: drained, watertable deeper than 5 m
Moistness: dry
Salinity: saltfree
Biology: few roots throughout the profile
Land-use: dry-farming, fallow
Classification: 1964 Calciustollic Calciorthid
1967 Calcixeroll

Table 18. Analytical data of Profile 43

Depth	Particle-size distribution ($-CaCO_3$)			$CaCO_3$ eq.	pH	ECe
	< 2μm	2–50μm	> 50μm			
0– 10	—	—	—	—	7.40	0.52
10– 20	—	—	—	—	7.42	0.48
20– 30	15.5	7.0	77.5	1.7	—	—
30– 40	—	—	—	—	7.52	0.35
50– 60	—	—	—	—	7.54	0.36
70– 80	—	—	—	—	7.58	0.33
90–100	9.6	7.2	83.2	19.2	7.59	0.34
110–120	—	—	—	—	7.56	0.37

Tablo 18. Profil 43'e ait analitik bilgiler.

Soil description of Profile 43.

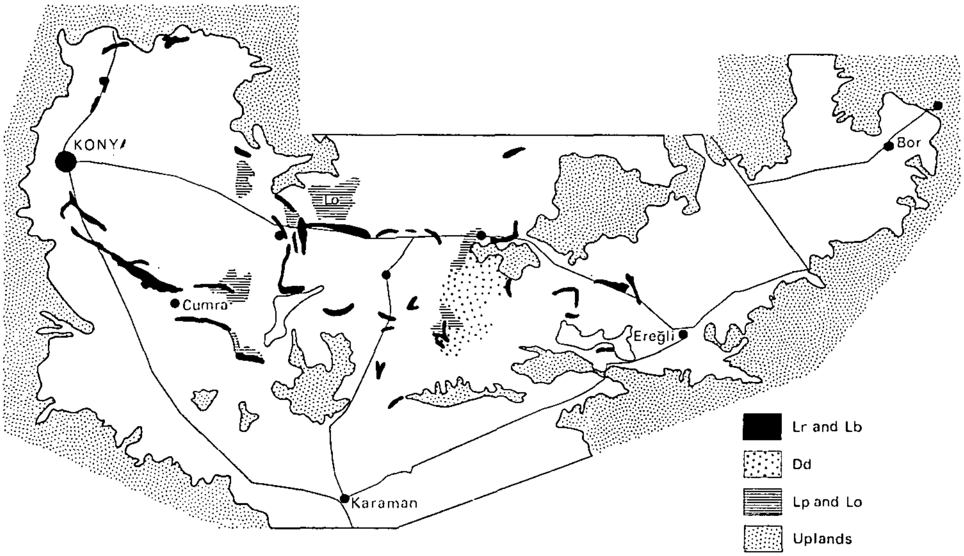
Ap	0– 20 cm	dark-brown (10YR 3/3) sand, grayish-brown (10YR 5/2) when dry; single grain; non-sticky non-plastic when wet, very friable when moist, slightly hard when dry; common medium gravel; common macropores, few mesopores; few shell fragments; few coloured sandgrains; clear smooth boundary.
B2	20– 53 cm	dark-brown (10YR 3/3) sand, brown (10YR 4/3) when dry; massive; non-sticky non plastic when wet, very friable when moist, slightly hard when dry; common medium gravel; common macropores, few mesopores; diffuse wavy boundary.
B3ca	53– 67 cm	dark-grayish-brown (10YR 4/2) sand, grayish-brown (10YR 5/2) when dry; massive; non-sticky, non-plastic when wet, very friable when moist, slightly hard when dry; common medium gravel; common distinct pseudo-mycelium; common macropores; irregular diffuse boundary.
C1ca	67– 80 cm	grayish-brown (10YR 5/2) sand, light-brownish-gray (10YR 6/2) when dry; massive, slightly cemented; common distinct pseudo-mycelium; common medium gravel; common macropores and mesopores; non-sticky non-plastic when wet, very friable when moist, slightly hard when dry; diffuse wavy boundary.
C2ca	80–126 cm	grayish-brown (10YR 5/2) sand, light-brownish-gray (10YR 6/2) when dry; massive, non-sticky non-plastic when wet, very friable when moist, slightly hard when dry; slightly cemented; common faint medium calcareous spots; common macropores and mesopores; few shells; common medium gravel; diffuse wavy boundary.
C3	126–168 cm	dark-grayish-brown (10YR 4/2) sand, light-brownish-gray (10YR 6/2) when dry; single grain; non-sticky non plastic when wet, very friable when moist, loose when dry; much medium gravel, common macropores and mesopores; common shells.

This profile has an umbric (almost mollic) epipedon and a calcic horizon.

Lr Sandridge Soils (Fig. 53). About 20 isolated sand and gravel ridges were formed along the former shores of the ancient lake. The water level must have been almost constant because the ridges (Lr) and beaches (Lp) are all at about 1017 m. However, in some places near Demirkent (Çumra Area,) Karapınar and Yelekli Yayla (Hotamış Area), there is a series of ridges, which may indicate small variations in the level. The mineralogical composition of the sandridges reflects the local products of wave erosion. Most ridges have a coarse sandy and fine gravelly surface and layers of coarse gravel and shells in the subsoil. The geomorphology and geogenesis of the sandridges is discussed in Chapter 2 and by Nota & van Beek (Part B). Some ridges, like the one north of Çumra are cultivated and even irrigated. Old arable land is found here. Other ridges like the ones near Arikören (Çumra Area) are used for cultivating grapes. Their main practical use, however, is as a source of sand and gravel for building and road making.

LrA High (Fig. 52, Profile 43 and Table 18) are deep stratified commonly gravelly, mainly single-grain sands. The top 50 cm is often less gravelly, and darker because of cultivation. The ridges are about 4 to 6 m high and at Tömek (Konya Area) 10 m. The stratification shows characteristic sedimentation patterns like crossbedding. Some layers consist of shells and shell fragments (mainly *Dreissenia* spp.). Width and shape of the sandridges varies much as can be seen on the soil map. They are extremely well drained and saltfree. The wide ridges are nearly level at the top.

Fig. 53. Distribution of Ridge Soils (Lr) Sandplains and Beach Soils (Lp). Soils of the Old Sandplain (Lo) and Sand Dunes (Dd).



Şekil 53. Sedde Toprakları (Lr), Kumlu ova ve Kıyı Toprakları (Lp); Eski Kumlu ova Toprakları (Lo) ve Kum kümeleri (Dd) nin dağılışları.

The safety of the ridges from floods and freedom of salts has made the big flat ridges places where cultivation has been practised for many centuries.

LrB Low are similar in type and variability to LrA but are no more than 3 m high and generally narrower. Occasionally flooding has given them a loamy surface soil.

Lp Sandplain and Beach Soils Besides ridges (Lr), the Ancient Lake Konya has deposited sandbeaches along escarpments and slopes. Locally in the Lacustrine Plains, flat sandplains have been deposited. Both Beaches and Sandplains have been formed in turbulent parts of the lake with strong currents. Extensive Sandplains may therefore be expected in straits between subbasins, and near large sources of sand as south of Karapınar and around Demirkent. The sands near Karapınar have been blown to dunes, which are described later (Dd).

LpA Dark-grayish-brown (Figs. 54 and 55, Profile 44 and Table 19) are deep, dark-grayish-brown (10YR 3/2) single-grain or slightly cemented loamy sands or sands. Locally there is a clear well-developed calcic horizon. Rodents (*Citellus* and *Spalax* spp.) are very active in these soils (de Meester, Part B). They are moderately well to poorly drained, slightly salt-affected, flat and level, locally with low sand dunes. They occur some 10 km south from Karkin and north of Arikören (both Çumra Area) and form range.

LpB Pale-brown stratified carbonatic, with shell fragments (Fig. 56, Profile 45) are very deep, pale-brown (10YR 5.5/3) single-grain carbonatic sands with stratified layers of loam, gravel and shells and locally a calcic horizon. The unit is complex therefore. They are well drained, saltfree, flat and nearly level, often hummocky (Fig. 56). Locally there are small sand dunes as indicated on the Soil Map.

They occur in small plains some 6 km south-east of Karakaya (Konya Area), 8 km north-east of Demirkent (Hotamış Area) and in a large plain about 10 km north of Serpec. They form range.

LpC Carbonatic, with dark volcanic surface (Fig. 57 and Profile 46) form a large sandplain south of Karapınar near the volcanic Meke Dağ with soils similar to LpB, except that the surface contains much dark volcanic mineral. The top 5 cm of purely volcanic material is almost black. This cover has prevented wind erosion. No hummocks or dunes occur here and they are flat and nearly level (Fig. 3). They form range except for small areas where melons are dry-cultivated.

LpD Reworked, complex stratified cover an area about 6 km north-west of Üçhüyükler (Çumra Area) of sandy soils presumably derived from LpA but eroded and reworked by annual flooding into an intricate soil pattern that even in semi-detail had to be mapped as a complex. They are poorly drained, moderately to strongly salt-affected, flat and nearly level. They are mainly range. Arable land is scattered in the higher parts.

Lo Old Sandplain Soils North of the main asphalt road near Merdiven Yayla (Hotamış Area) is an area with sandy soils between 1020 and 1050 m above sea-level. Although the sands seem of lacustrine origin (mixed with shell fragments) they lie

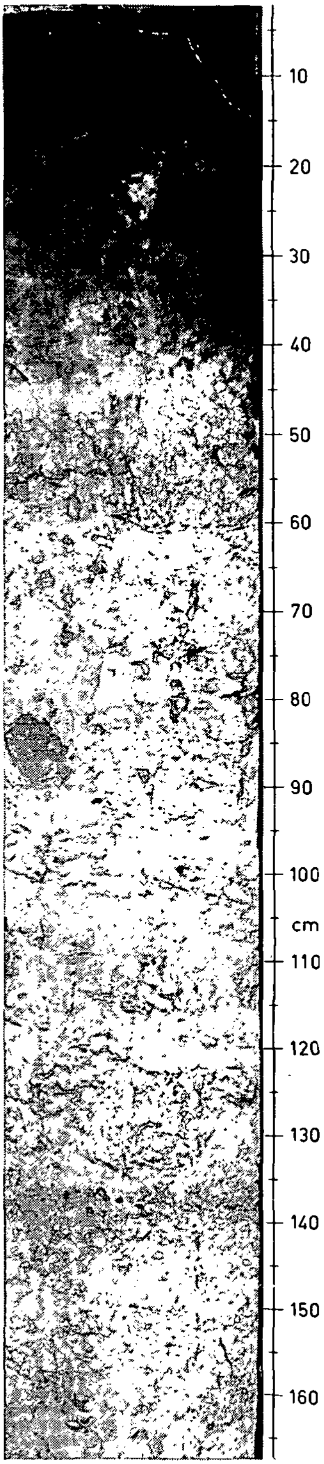


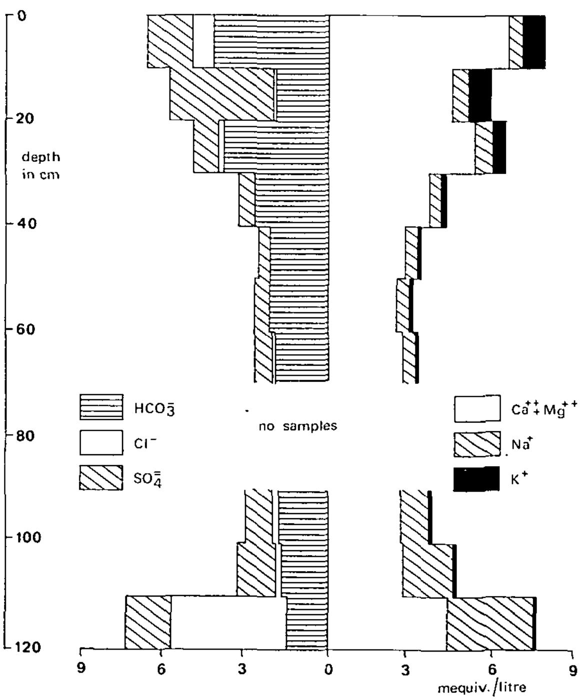
Fig. 54. Profile no 44.
Şekil 54. Profil no. 44.

LpA Dark-grayish-brown Sandplain and Beach Soils

Great Konya Basin, Çumra Area, 65.4N, 91.8E, alt. about 1010 m, 5–6–1964 (van Blom)

Geomorphology: lacustrine sand plain
Parent material: calcareous sand and loamy sand
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: well drained, watertable about 3 or 4 m
Moistness: dry
Salinity: saltfree
Biology: common roots from 0–43 cm, krotovinas between 40–90 cm
Land-use: ranging
Classification: 1964 Calciustollic Calciorthid
1967 Calcixeroll

Fig. 55. Ion balance of Profile no 44.



Şekil 55. Profil 44' de iyon dengesi.

Table 19. Analytical data of Profile 44.

Horizon	Depth (cm)	Particle-size distribution						$CaCO_3$eq. (%)
		< 2μm		2–50μm		> 50μm		
		$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	
A11	0– 5	12.5	8.5	1.4	8.1	86.1	83.4	3.9
A11	5– 10	16.0	11.9	1.9	7.3	82.1	81.6	3.2
A12ca	25– 35	21.3	21.7	6.0	9.3	72.7	69.2	10.6
B2ca	40– 50	26.2	32.1	8.8	17.5	65.0	50.4	24.8
B2ca	65– 75	26.5	42.4	11.3	15.7	62.2	43.3	35.7
B2ca	90–100	18.3	26.5	11.6	31.2	70.1	43.7	37.2
C1ca	130–140	20.2	19.7	12.1	19.7	67.7	61.3	27.6
C2ca	150–160	11.7	16.4	5.5	15.7	82.8	69.0	23.4

Depth	pH	ECe	Depth	pH	ECe
0–10	7.39	0.75	60– 70	7.68	0.32
10–20	7.28	0.57	70– 80	—	—
20–30	7.43	0.58	80– 90	—	—
30–40	7.50	0.41	90–100	7.74	0.37
40–50	7.60	0.33	100–110	7.87	0.47
50–60	7.64	0.31	110–120	7.93	0.89

Tablo 19. Profil 44'e ait analitik bilgiler.

Soil description of Profile 44.

Soil description 44.

A11 0– 10 cm very dark grayish-brown (10YR 3/2) loamy sand, brown (10YR 4/3) when dry; massive; slightly sticky non-plastic when wet, very friable when moist, soft when dry; few macropores, common mesopores; few small shell fragments; common roots; clear smooth boundary.

A12ca 10– 43 cm sandy clay-loam, slightly lighter coloured; calcareous spots; gradual irregular boundary.

ACca 43– 97 cm light-gray (10YR 7/2) sandy clay-loam, white (5Y 8/1) when dry; massive; sticky slightly plastic when wet, firm when moist, very hard when dry; few small shell fragments, abundant calcareous concretions and spots; common mesopores, few macropores; gradual wavy boundary.

C1ca 97–137 cm similar colour, sandy loam with less calcareous spots than ACca and coarser-textured.

C2ca 137–170 cm grayish-brown (2.5Y 5/2) loamy sand, light-brownish-gray (2.5Y 6/2) when dry; single grain; slightly sticky non-plastic when wet, very friable when moist, soft when dry; few macropores, common mesopores; common shells and fragments; few medium prominent calcareous concretions.

This profile has a mollic epipedon and a calcic horizon.

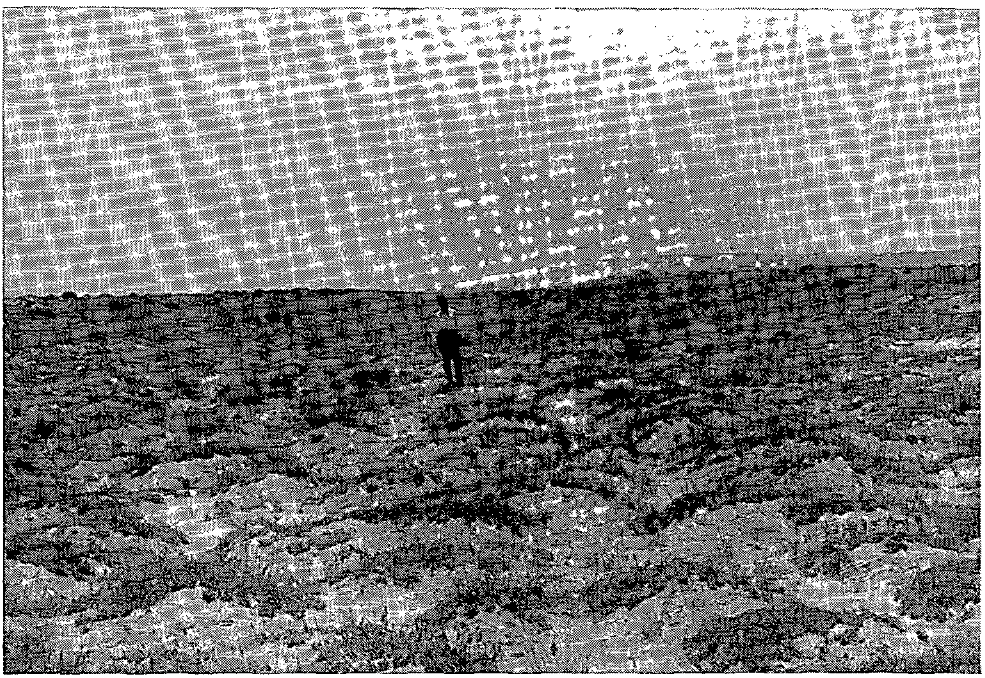
Profile 45.
Profil 45.

LpB Pale-brown stratified carbonatic Sandplain and Beach Soils with shell fragments.

Great Konya Basin, Karapınar Area, 53.5N, 141.6E, alt. about 1002 m, June 1965 (Groneman)

Geomorphology: old lacustrine beach
Parent material: calcareous sand with some gravel
Relief and slope: subnormal, gently sloping
Stoniness: Class 0
Hydrology: well drained, watertable about 15 m
Moistness: dry
Salinity: saltfree
Biology: few roots decreasing to 150 cm
Land-use: dry-farming, wheat and rye
Classification: 1964 Typic Camborthid
1967 Stratic Camborthid

Fig. 56. Sandplain Soils (LpB) south of Karapınar, Karapınar Area, with hummocky microrelief.



Şekil 56. Karapınar bölgesinde Karapınar'ın güneyinde, tümsek mikro röliefli Kumlu ova Toprakları (LpB).

Soil description of Profile 45.

Ap1 0– 15 cm brown to pale-brown (10YR 5.5/3) loamy very fine sandy with some gravel, very pale-brown (10YR 7/3), when dry; very weak medium subangular-blocky structure; slightly hard very friable slightly plastic slightly sticky; common macropores and mesopores; clear smooth boundary.

Ap2 15– 28 cm brown to pale-brown (10YR 5.5/3) loamy very fine sandy with some gravel, very pale-brown (10YR 7/3), when dry; weak thick platy structure, breaking to coarse angular-blocky elements; slightly hard friable to firm slightly plastic slightly sticky; very few macropores and few mesopores; gradual wavy boundary.

B2ca 28– 59 cm light-brown-gray (10YR 6/2) silt-loam, white (10YR 8/2) when dry; weak coarse subangular-blocky structure; slightly hard friable slightly plastic slightly sticky; few macropores and common mesopores; common medium distinct yellowish-brown (10YR 5/6) and yellowish-red (5YR 5/6) rust mottles; common medium distinct calcareous spots; gradual wavy boundary.

C1 59–140 cm light-brownish-gray (10YR 6/3) successive layers of carbonatic silt-loam and very fine sand, very pale-brown (10YR 7/3) when dry; layers at angle of about 30° to horizontal upwards; silt-loam layers have moderate coarse angular-blocky structure and the very fine sandlayers have weak coarse subangular-blocky structure; many coarse prominent yellowish-red (5YR 5/6) rust mottles; rust concentrated in sand layers; abrupt wavy boundary.

C2 140–150 cm light-brownish-gray (10YR 6/3) very fine sand, very pale-brown (10YR 7/3) when dry; massive loose when dry or moist, non-plastic non-sticky; many coarse prominent rust mottles.

This profile has an ochric epipedon and a cambic horizon.

Profile 46.
Profil 46.

LpC Carbonatic Sandplain and Beach Soils with dark volcanic surface

Great Konya Basin, Karapınar Area, 66.6N, 150.8E, alt. 1000 m, June 1965 (Groneman)

Geomorphology: lacustrine plain
Parent material: lacustrine deposits derived from volcanic ash, sand and gravel.
Relief and slope: subnormal, level
Stoniness: Class 0
Hydrology: well drained, watertable about 10 m
Moistness: dry
Salinity: saltfree
Biology: krotovinas, 0–50 cm plentiful fine roots, decreasing downwards
Land-use: ranging, mainly *Peganum harmala* vegetation
Classification: 1964 Typic Vitrandept
1967 Entic Vitrandept

Soil description of Profile 46.

A1 0– 50 cm dark-grayish-brown to grayish-brown (10YR 4.5/2) gravelly coarse sands, grayish-brown to light-brownish-gray (10YR 5.5/1) when dry; dark-brown to black pebbles; massive; loose to soft when dry, loose to very friable when moist, slightly plastic slightly sticky; common macropores and mesopores; few krotovinas; asymmetrical ripples on the surface up to about 8 cm high; locally desert pavement; abrupt irregular boundary.

AC	50– 72 cm	pale-brown (10YR 6/3) gravelly loamy sands, white (10YR 8/2) when dry; weak medium subangular-blocky structure; hard, firm; plastic, slightly sticky; in lower part few fine distinct rust mottles; few krotovinas; clear irregular boundary.
C1	72–150 cm	very pale-brown (10YR 7/3) silt-loam to silty clay-loam, white (10YR 8/2) when dry; moderate coarse angular-blocky structure; very hard, very firm, very plastic sticky to very sticky; few fine faint distinct rust mottles.

This profile has an ochric (almost mollic) epipedon, a cambic horizon.

Fig. 57. Melon cultivation without irrigation in the Volcanic sandy surface soil of unit LpC, Karapınar Area, southeast of Karapınar. In background volcanic Uplands (UvA).

Şekil 57. Karapınar bölgesinde, Karapınar'ın güney doğusunda Volkanik kumlu yüzey topraklara sahip ünitede (LpC) kavun yetiştirilmesi. Arka plânda volkanik yüksek araziler (UvA).

outside the limits of the Pleistocene ancient Lake Konya. Presumably they are early Pleistocene or Tertiary and might been deposited during a period with lake levels between 1020 and 1050 m. They cover Neogene structural terraces and follow their topography. Sudden changes in level may easily be mistaken for sandridges but are in fact escarpments in the terraces. Parts with deep sands where the natural vegetation has been removed as fuel have shifting dunes.

LoA Undulating deep are deep, light-brown calcareous sands without profile development. The soils are well drained and saltfree. The unit is uniform except in topography and locally has sand dunes.

They occur in the western part of the association. They have a natural vegetation only of *Artemisia scoparia* which is not grazed.

LoB Nearly flat shallow, over terrace are well drained saltfree shallow calcareous sands over highly calcareous loam. The unit is complex with variations in depth of sand and in subsoil profile. The sand forms beaches against escarpments in the terraces, but no ridges. They are ranged and scattered fields are under dry barley or rye.

5.8 M **Marshes** (Fig. 43)

There are large marshes at Aslım, north-east of Konya, and north-west and west of Ereğli. The Aslım Marsh has been studied (See App. 2, sample areas) but the Ereğlı Marshes were only partly explored because of their inaccessibility. Marshes are widespread at the foot of alluvial fans and near lakes, where seepage water cannot be immediately removed by drainage and evaporation. The landscape comprises one association and four units, all complex:

Mf Marsh soils

- MfA Carbonatic clay or soft lime, with dark surface soil (near Ak Göl)
- MfB Carbonatic clay with organic surface soil, deep black in many creeks (near Hortu)
- MfC Soft and crusted calcareous tufa (near Aslım)
- MfD Soft gypsum (near Aslım).

Mf Marsh Soils Due to a constant supply of carbonate-rich water, lime has precipitated in the Marsh Soils in several ways: from groundwater around roots, in soil pores and in layers; but also from open water on waterplants and algae. Periods of carbonate precipitation have alternated with sedimentation of mineral matter and organic material. As a result Marsh Soils are extremely complex horizontally and vertically. In the Aslım swamps a certain zonality or horizontal sequence was observed in precipitation of lime, gypsum and more soluble salts from the springline onward.

MfA Carbonatic clay or soft lime with dark organic surface soil consists of stratified black organic clay and light-gray or white soft lime or carbonatic clay with numerous springs. They are poorly drained (MfA) or moderately well drained (MfA^1), only locally salt-affected, flat and nearly level. They occur at the very base of the Zanopa Fan (Ag), Ereğli Area. They are covered with natural marsh vegetation which is ranged (MfA) or under irrigated wheat (MfA^1).

MfB Carbonatic clay with organic surface soils; deep black in many creeks is a complex of hydromorphic deep organic clayey creeks and better drained islands whose soils are mostly of shallow dark organic clay over marl (LmC). This marsh receives excess water from the east of the Basin and from the Zanopa Fan. This water eventually collects in the Ak Göl depression. In 1967 new canals were dug near

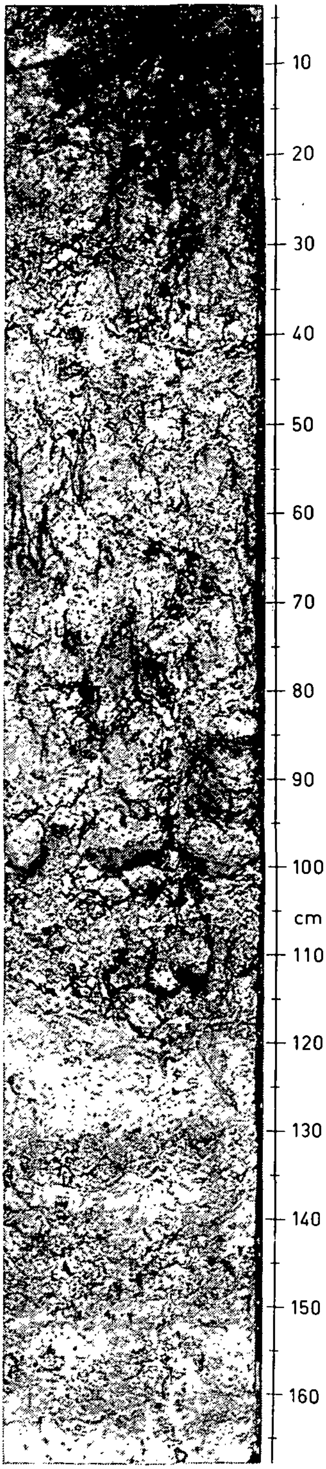


Fig. 58. Profile no 47.
Şekil 58. Profil no. 47.

MfC Carbonatic Marsh Soils with hardpan (Aslım)

Great Konya Basin, Konya Area, 98.9N, 63.2E, alt. about 1000 m, 21–8–1964 (van Blom)

Geomorphology: marsh
Parent material: soft lime
Relief and slope: flat, level
Stoniness: Class 0
Hydrology: very poorly drained, watertable 30 cm in summer, submerged in winter
Moistness: moist
Salinity: strongly salt affected
Biology: abundant roots to 29 cm, common roots from 29–96 cm, few roots 96–164 cm
Land-use: ranging
Classification: 1964 Typic Haplaquent
1967 Typic Haplaquent

Table 20. Analytical data of Profile 47

Horizon	Depth	Particle-size distribution (+$CaCO_3$)			$CaCO_3$ eq.
		< 2μm	2–50μm	> 50μm	
C1	50–60	6.5	20.3	73.2	96.2

Tablo 20. Profil 47'ye ait analitik bilgiler.

Soil description of Profile 47.

A11	0– 19 cm	dark-gray (10YR 4/1.5) pseudo-loam, gray (10YR 6/1) when dry; weak medium subangular-blocky structure; non-sticky, non-plastic when wet, loose to very friable when moist, soft when dry; many macropores and mesopores; abundant roots; common somewhat porous hardened calcareous concretions with many root holes about 5 mm wide and 15 mm long; common shells; clear smooth boundary.
A12	19– 29 cm	similar but slightly lighter.
C1	29– 96 cm	grayish-brown (10YR 5/2) (pseudo) sandy loam, light-gray (10YR 7/2) when dry; single grain, weakly cemented; non-sticky non-plastic when wet, loose to very friable when moist, slightly hard when dry; many macropores and mesopores; common roots; many to abundant coarse somewhat porous hardened calcareous concretions with many root holes; common shells; gradual smooth boundary.
C2	96–117 cm	pale-brown (10YR 6/3.5) when moist, somewhat hardened calcareous concretions with many root holes and pores very pale-brown (10YR 8/3) when dry, slightly hardened coarse pieces of calcareous tufa; non-sticky non-plastic when wet, loose to very friable when moist, slightly hard when dry; many macropores and mesopores; few roots; few shells; clear smooth boundary.
C3	117–130 cm	similar but yellowish-brown (10YR 6/4) when moist, very pale-brown (10YR 7/3) when dry.
C4	130–137 cm	light-yellowish-brown (10YR 6/4) calcareous grains, very pale-brown (10YR 7/3) when dry, structureless and cemented; non-sticky non-plastic when wet, loose to very friable when moist, slightly hard when dry; many macropores and mesopores; few roots; few shells.
C5	137–140 cm	like C3 but light-yellowish-brown (10YR 6/4) when moist, very pale-brown (10YR 7/3) when dry.
C6	140–151 cm	like C4.
C7	151–156 cm	like C5.
C8	156–164 cm	like C4.

This profile has an ochric epipedon.

Hortu to improve drainage.

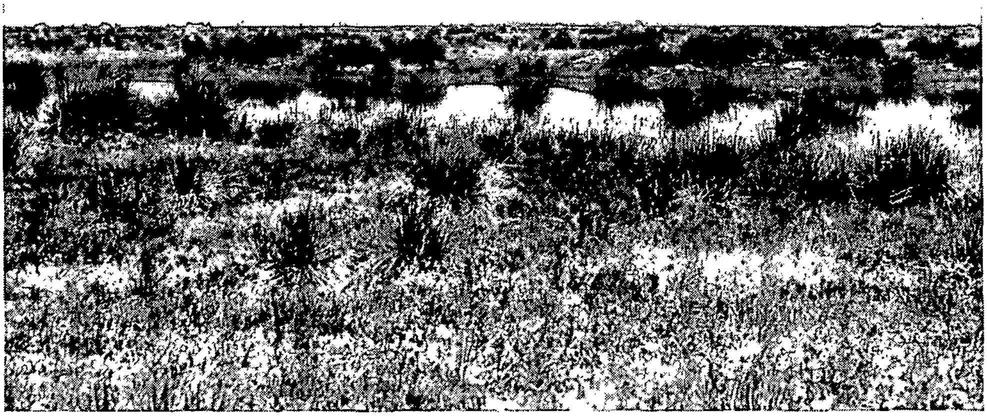
MfC Soft and crusted calcareous tufa (Figs. 58 and 59, Profile 47 and Table 20). Complex unit of pure calcareous tufa soils with varying profile features. Commonly found are deep, white waterlogged profiles with a granular or spongy structure but composed of 80–90% calcium and magnesium carbonates. The carbonates presumably precipitated by biogenetic and chemical processes and at 100 or 200 cm have formed hard crusts. Under this tufa lies lacustrine marl at about 200 or 300 cm.

They are poorly drained and only slightly salt-affected except at the surface which is flat and nearly level with a changing pattern of watercourses. They occur 10 tot 15 km north-east of Konya and a government experimental station has been established in the middle. They are covered with marsh vegetation but introduction of suitable grasses would be possible with drainage (Çuhadaroğlu, 1966).

MfD Soft gypsum. An elongated slightly elevated area bordering the Aslım marsh, with soils of pure soft gypsum whose genesis could not be elucidated.

They are poorly drained, salt-affected, flat and nearly level. They form poor range.

Fig. 59. Marsh on calcareous Tufa Soil (MfC) near Aslım Experimental Station, Konya Area. Vegetation is mainly *Juncus maritimus*.



Şekil 59. Konya bölgesinde, Aslım Deneme İstasyonu Yakınlarında, Kalkerli tufa topraklar (MfC) üzerindeki bataklık. Tabii bitki örtüsü genel olarak *Juncus maritimus* dır.

5.9 D **Aeolean Sandplain** (Fig. 53)

The sand deposits south of Karapınar have been eroded by the wind because of disturbance of their natural vegetation, giving rise to a large area of sand dunes. Part has been stabilized by vegetation but much is covered by high and low sand dunes encroaching slowly north-eastwards. The sand is medium fine grained and is about 70 % calcium carbonate in the form of rounded grains and very small shell fragments. The sand dune area is now enclosed and measures are being taken to control erosion by Topraksu, a Turkish Government organisation (Fig. 60). For detailed information see Groneman (1968). This landscape comprises one association and two units.

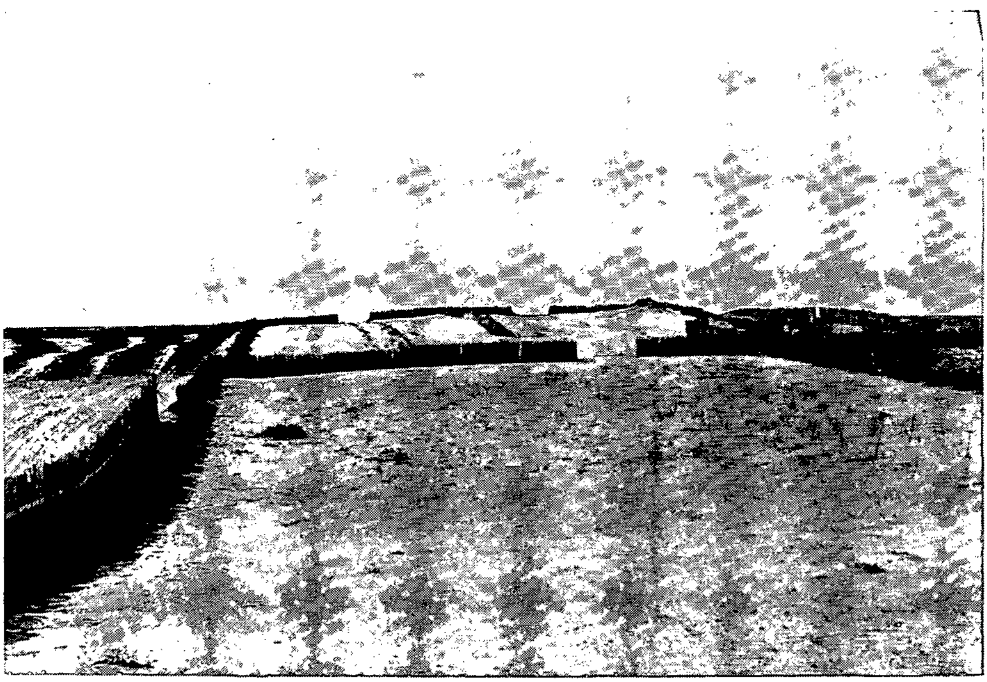
Dd Sand Dunes

DdA Complex of mainly shifting sand dunes

DdB Stabilized sandy, locally shallow over carbonatic clay

Dd Sand dunes Shifting sands cannot support plants and consequently are not soil. Both shifting and stabilized sand dunes occur in a complicated pattern.

Fig. 60. Control of erosion by windbreaks in the shifting Sanddunes (DdA), Topraksu Erosion Control Camp, Karapınar Area.



Şekil 60. Karapınar bölgesinde Topraksu Erozyon Kontrolu Kampında hareket halindeki kumulların (DdA) rüzgâr kırıcılarıyla kontrolü.

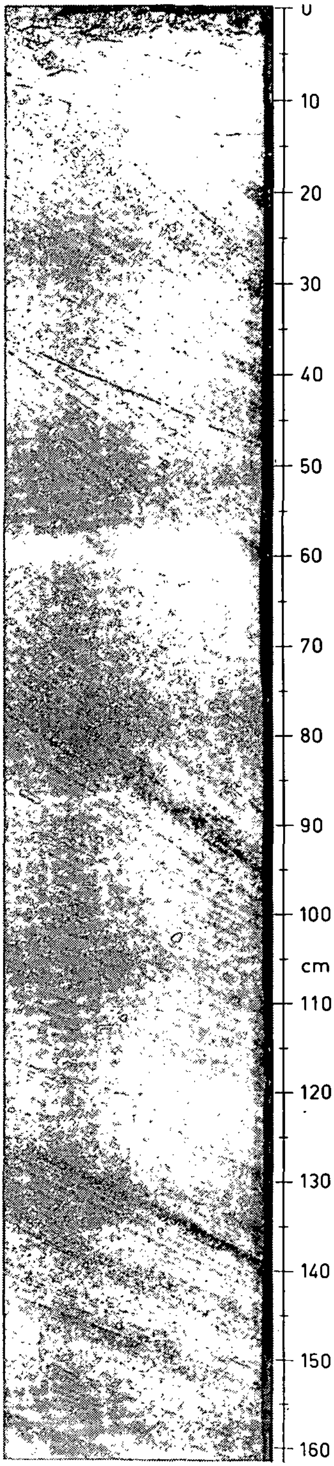


Fig. 61. A. Profile no 48.
B. Position of profile in Barchane dune (upper view).
Şekil 61. A. Profil no. 48. B. Barchan tipi kum tepeleri içersinde profilin yeri (üst görünüş).

DdA Complex of mainly shifting Sand Dunes

Great Konya Basin, Karapınar Area, 65.0N, 145.0E, alt. 1000 m, 15-5-1965, (Groneman)

Geomorphology: aeolian sandplain, shifting dunes
Parent material: highly calcareous aeolian sand of lacustrine origin
Relief and slope: normal, hilly, severely blown out
Stoniness: Class 0
Hydrology: excessively drained, watertable about 20 m
Moistness: 0-70 cm dry, 70-170 cm moist
Salinity: saltfree
Biology: no roots
Land-use: useless
Classification: no profile development.
Soil description of Profile 48.

C1	0- 2 cm	light-brownish-gray (10YR 6/2) sand, light-gray (10YR 7/2) when dry; single grain; non-sticky non-plastic; loose when moist or dry; on surface many shell fragments and coarse sandgrains; very many macropores many mesopores; abrupt smooth boundary.
C2	2- 70 cm	light-brownish-gray (10YR 6/2) dry, stratified fine sand, light-gray (10YR 7/2) when dry; the layers dip at 20°; single grain non-sticky non-plastic loose when moist, loose when dry; very few macropores many mesopores; diffuse smooth boundary.
C3	70-165 cm	light-brownish-gray (10YR 6/2) moist stratified fine sand, light-gray (10YR 7/2) when dry; otherwise as above.

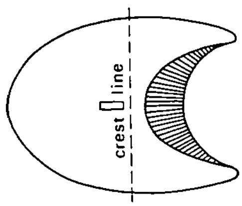


Table 21. Analytical data of Profile 48.

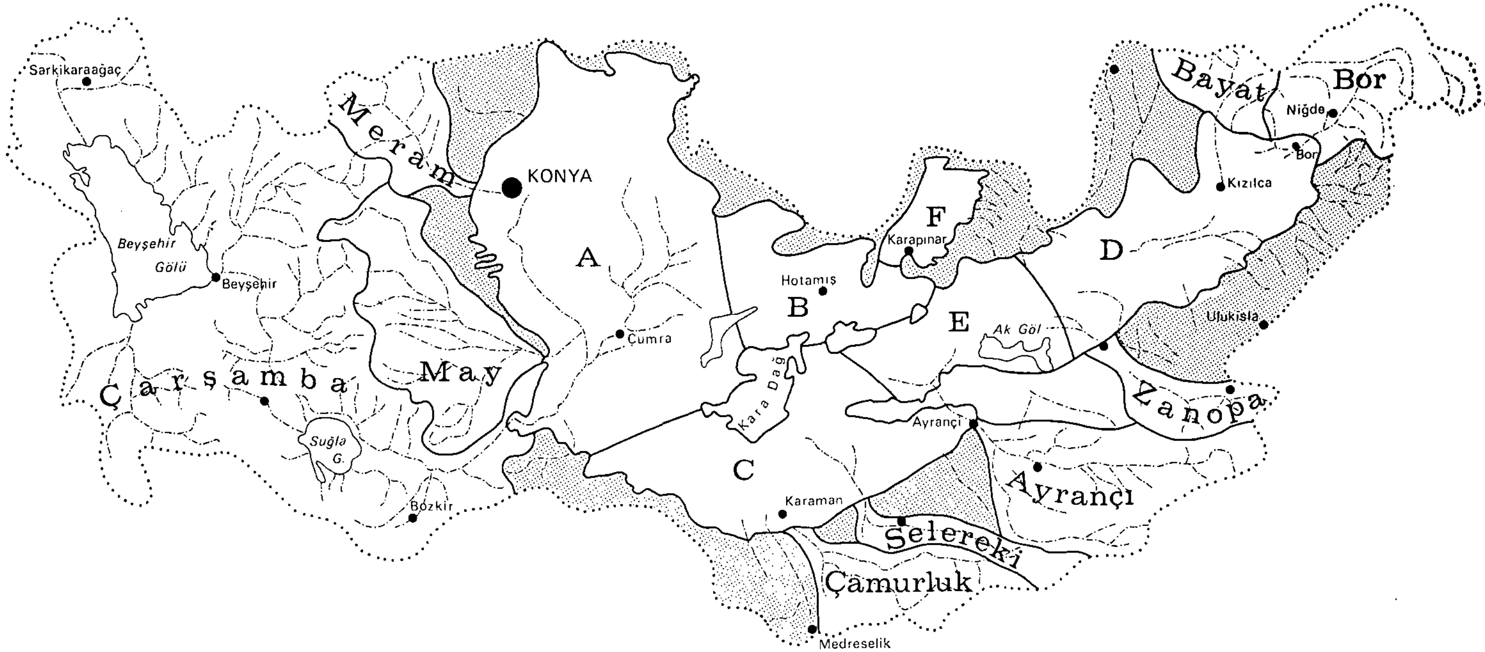
Horizon	Depth	Particle-size distribution						$CaCO_3$eq.
		< 2μm		2–50μm		> 50μm		
		$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	$-CaCO_3$	$+CaCO_3$	
C1 + C2	0– 50	5.7	4.7	8.5	5.5	85.8	89.8	76.5
C2	50– 70	24.4	6.8	9.7	3.7	65.9	89.5	77.7
C3	70–110	20.2	5.2	9.6	3.6	70.2	91.2	78.3

Tablo 21. Profil 48'e ait analitik bilgiler.

DdA Complex of mainly shifting sand dunes (Figs. 61A and 61B, Profile 48 and Table 21) are very deep well-drained and non-saline stratified carbonatic fine sands without profile development. The unit is complex, consisting mainly of shifting dunes but also areas covered with natural vegetation. Between the dunes are patches of fine carbonatic clay of the marlplain over which the dunes are moving. The dunes vary between 3 and 10 m high.

DdB Stabilized sandy, locally shallow over carbonatic clay. Deep carbonatic sands with a weakly cemented horizon of calcareous segregation. The dunes are smooth in shape. Beside high dunes, small ones occur and between the dunes the soil may be shallow over fine carbonatic clay. They are covered with natural vegetation and may be ranged. Overgrazing, however, will inevitably lead to wind erosion and formation of shifting dunes.

Fig. 62. Boundaries of the river catchment areas and of hydrological units in the Basin.



Boundary of catchment area of the Great Konya Basin / Büyük Konya Havzası'nın su toplama sınırı

May — Boundary of catchment area of a river and its name / Çayların su toplama sınırı ve isimleri

Collective catchment area of small rivers and gullies / Toplu olarak küçük çay ların ve galirerin su toplama sahaları

Rivers or gullies / Nehirler veya galiler

A — Hydrological unit / Hidrolojik unite

Şekil 62. Havzada su toplama sahalarının sınırları ve hidrolojik üniteler.

6 Hydrology and salinity

P. M. Driessen & A. L. van der Linden

6.1 Introduction

The Basin receives water partly directly as rainfall but mainly from the surrounding uplands. This supply enters the Basin as run-off, in streams or by underground seepage. As there is no outlet the watertable is high in lower parts and evaporation has caused salinization whose degree depends largely on local hydrological conditions (Driessen, 1970).

6.2 Hydrology

The upland catchment area (Fig. 62) consists of a narrow belt around the whole Basin with an annual precipitation similar to that of the depression, about 350 mm per year, and the Çarşamba watershed extending far to the south-west into the Toros Mountains with a precipitation of about 600 mm per year.

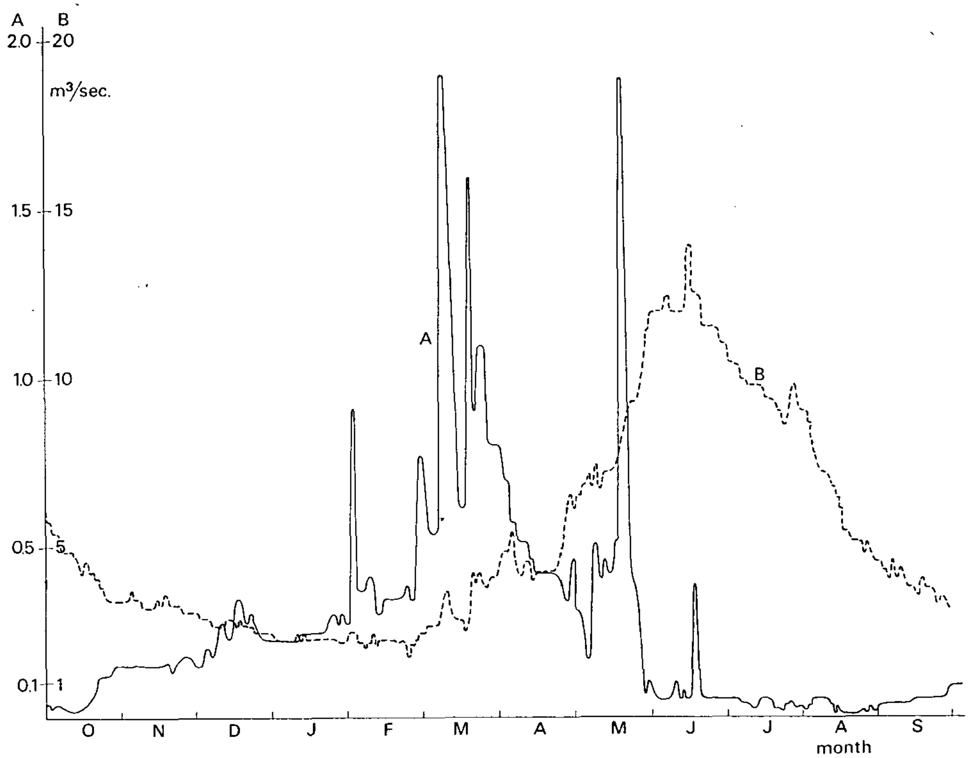
More difficult to evaluate is the seepage. Much of this comes from the wet southern slopes of the Toros Mountains through permeable strata to the south-east side of the Basin, where it appears as numerous springs. The River Zanopa near Ereğli brings in 8.4 times as much water as falls in its watershed and must therefore be fed mainly from springs.

Fig. 63 shows the difference in seasonal distribution of flow between the Zanopa and a rain-fed river, the River Bor. Table 22 gives hydrological data for the main rivers. The small flow in relation to total catchment indicates large losses, probably mainly by soak-away which contributes to groundwater but may be partly lost to deeper strata. Karstic phenomena are certainly of importance in the Basin itself.

Distribution and flow of groundwater Watertable varies during the year with precipitation, river flow, irrigation, seepage and evaporation. This was shown in a survey in 1967 of 350 wells over the whole Basin during a week in May at the end of rainy season and in September at the end of dry season. (Fig. 65). Seasonal differences in watertable were much greater at the border (5–10 m) than in the centre (0.25–0.5 m). The reason may be soak-away at the border through cavities in the Neogene limestone which is locally exposed but dips towards the centre under clastic deposits. This water emerges and mostly evaporates at the foot of bajadas and fans. In the centre the marl soils are saturated and drainage is impeded.

The general underground flow is from the border to the centre. Figure 64 illustrates

Fig. 63. Hydrographs of a mainly rain-fed river, the Bor (A) and a mainly spring-fed river, the Zanopa (B).



Şekil 63. Daha çok yağışlarla beslenen, Bor (A) ve daha çok ilkbahar yağışlarıyla beslenen, Zanopa (B) Çaylarının hidrografı.

Table 22. Hydrological data of local rivers measured above dam site

River	Catchment area (km^2)	Annual discharge ($m^3 \times 10^6$)	Total discharge in percentage of total catchment	Remarks
May	1411	73.4	10	rain river
Sille	38	2.4	18	rain river
Çarşamba	6780	207.9	5	rain river
Selereki[1]	225	17.6	50	spring and rain river
Ayranci	1390	31.7	8	spring river[2]
Zanopa	52	168.0	840	spring river
Bor	251	9.0	11	rain river

1. Measured above Ibrala.
2. Seems rain river, but is presumably spring river with large karstic losses. Sources: Big dams (1966), Water management (1965), Rasat (1966).

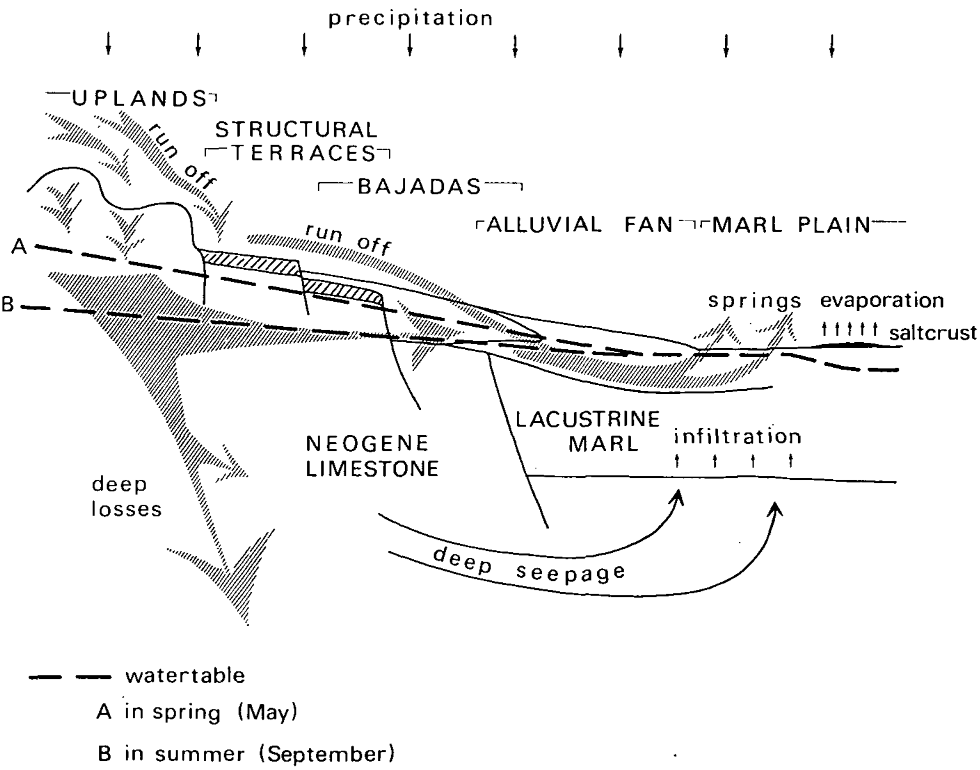
Tablo 22. Barajın bulunduğu yerlerin üzerinde. Bölgesel çaylara ait hidrolojik kayıtlar.

the sequence from uplands through Terraces, Bajadas and Fans to the Lacustrine Plain. The Terraces receive run-off mainly from the Uplands. Part goes to deeper strata and part to the thick permeable Bajadas and Fans. There the flow is augmented by soak-away of river and irrigation water. When the water reaches the impermeable marls of the Lacustrine Plain, it emerges as springs (Fig. 66) which usually form large marshes. The springs are rich in bicarbonate and soft lime is often precipitated, either around roots as in the Aslım Swamps or as white soft and hard lime layers or concretions as near Kaşınhanı, Ereğli and southwest of Bor.

In the Marl Soils of the Lacustrine Plain there is little or no horizontal flow. The supply is mainly upwards from underlying limestones which are connected with those at the border. Presumably they are in hydrostatic equilibrium with the border areas and therefore under slight pressure.

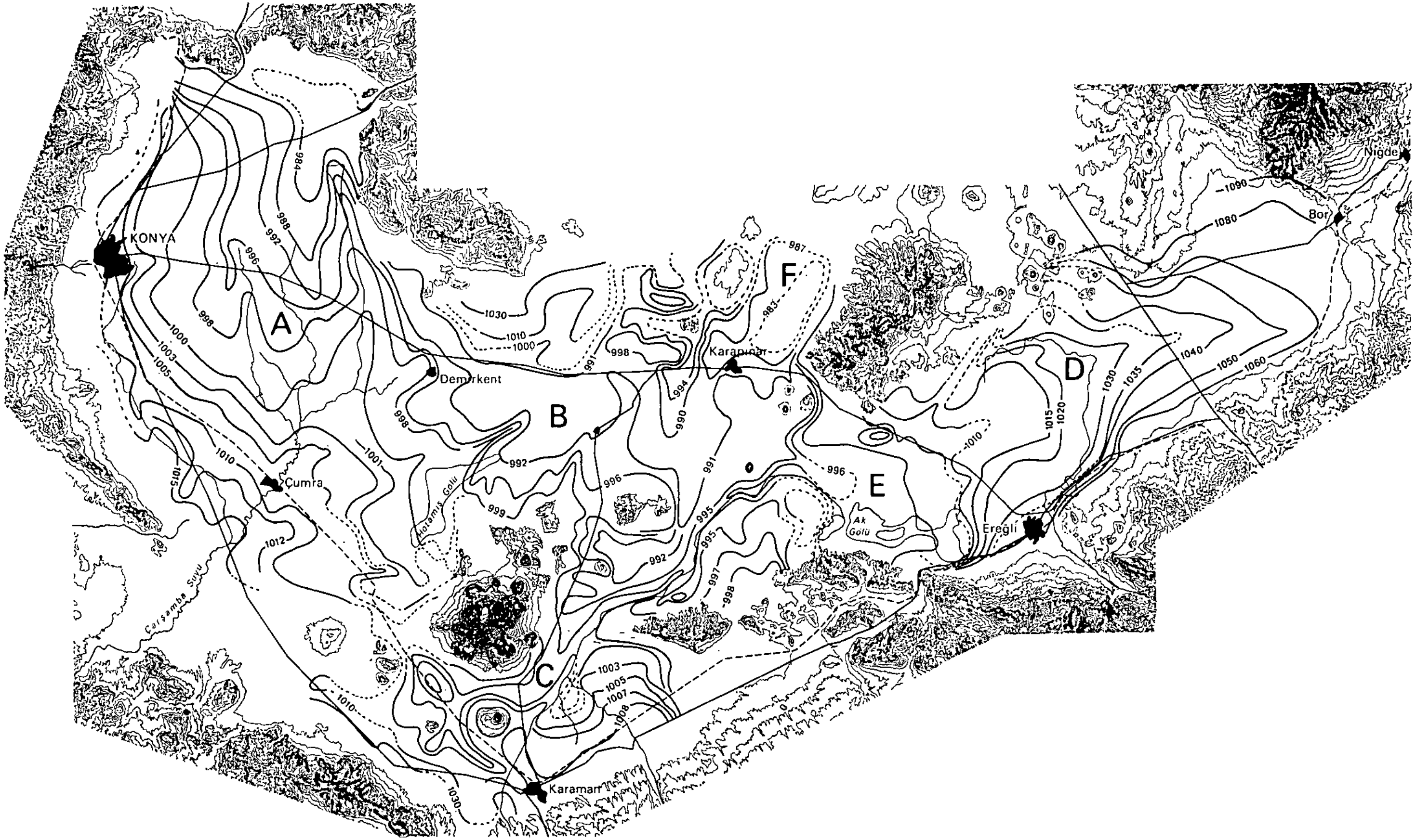
Hardly any water can be lost from the Basin except by evaporation, especially from open water, such as lakes and irrigation canals, and from areas with a high watertable.

Fig. 64. Flow through a schematic crossection of the Basin's border showing watertable in May (A) and in September (B).



Şekil 64. Havzanın kenarına doğru yapılan şematik kesit (A) Mayısta ve (B) Eylül'de tabansuyunu göstermektedir.

Fig. 65. Groundwater isohypses in May 1967 (above) and in September 1967 (below). For boundaries of hydrological units see Fig. 64.



Şekil 65. Mayıs 1967 de (A) ve Eylül 1967 de (B) tabansuyu izohipsleri. Hidrolojik ünitelerin sınırları için şekil 64 'de bakınız.

Fig. 66. Strong spring in the marsh near Aslım, Konya Area.

Şekil 66. Konya bölgesinde, Aslım yakınlarında bataklık içinde kuvvetli bir kaynak.

Hydrological units The Basin can be divided into six areas, each with a characteristic hydrology (Figs. 62 and 65).

Area A is separated from Area C by a divide for both run-off and groundwater. The patterns of isohypses suggest water seeps up from the underlying limestone strata in the central marl and infiltrates under the Çarşamba Alluvial Fan. From the surrounding uplands there are signs of supply from run-off and seepage. Seepage from the River Çarşamba flows north-east from where it enters the plain. Some miles downstream, the river receives groundwater from higher soils in spring but infiltrates them in September. The westernmost channel of the river flows throughout the year until it reaches the marlplain, where it soaks away. All other distributories of the Çarşamba act as soak-aways. The isohyps pattern along the border suggests the typical flow toward the centre. The watertable in the marl area (Lacustrine Plain) will be determined by the hydrostatic pressure in the deeper limestone strata except near infiltration channels.

Area B is a continuation of Area A, without surface water. The isohyps pattern is determined by the deeper groundwater in the underlying limestone, except for infiltration from the north-eastern arm of Hotamıs Gölü, which is of minor importance because of the poor permeability of the marls. The limestone is here and there 100 m deep. An underground divide can be detected from Hassanoba to Hotamış. West of this line there is little flow because the limestone is so deep. But to the east the flow eastward is greater because the limestone approach the surface. This groundwater is presumably pumped up in the Karapınar Erosion Control Camp.

Area C is an isolated hydrological unit, parted by an underground divide between Karaman and Eminler. West of this line deep groundwater flows through limestone. In the centre of this partition is a major fault. East of the line the watertable is shallower because of two alluvial fans of the Çamurluk and Selereki, and a drainage canal. Both fans are irrigated, resulting in differences in watertable of 1 to 1.50 m between May and September.

Area D receives supplies from the south and from small rivers in the east and north-east. It drains westwards. The depth and flow of groundwater depends on geology, topography and the soils. The slope and flow in the area is from the border inwards along the axis, which declines 1 per 1000. The underlying limestone also slopes towards the axis, forming a deep trough. Groundwater enters the area through permeable debris cones, alluvial fans and bajadas, flows westwards and collects in the deepest part of the trough. There is flow into Area E and Ak Göl. Surface run-off east of the 1020 m contour is presumably little, although the soil map shows a number of drainage gullies. West of the 1020 m contour, the groundwater is supplied mainly by the River Zanopa.

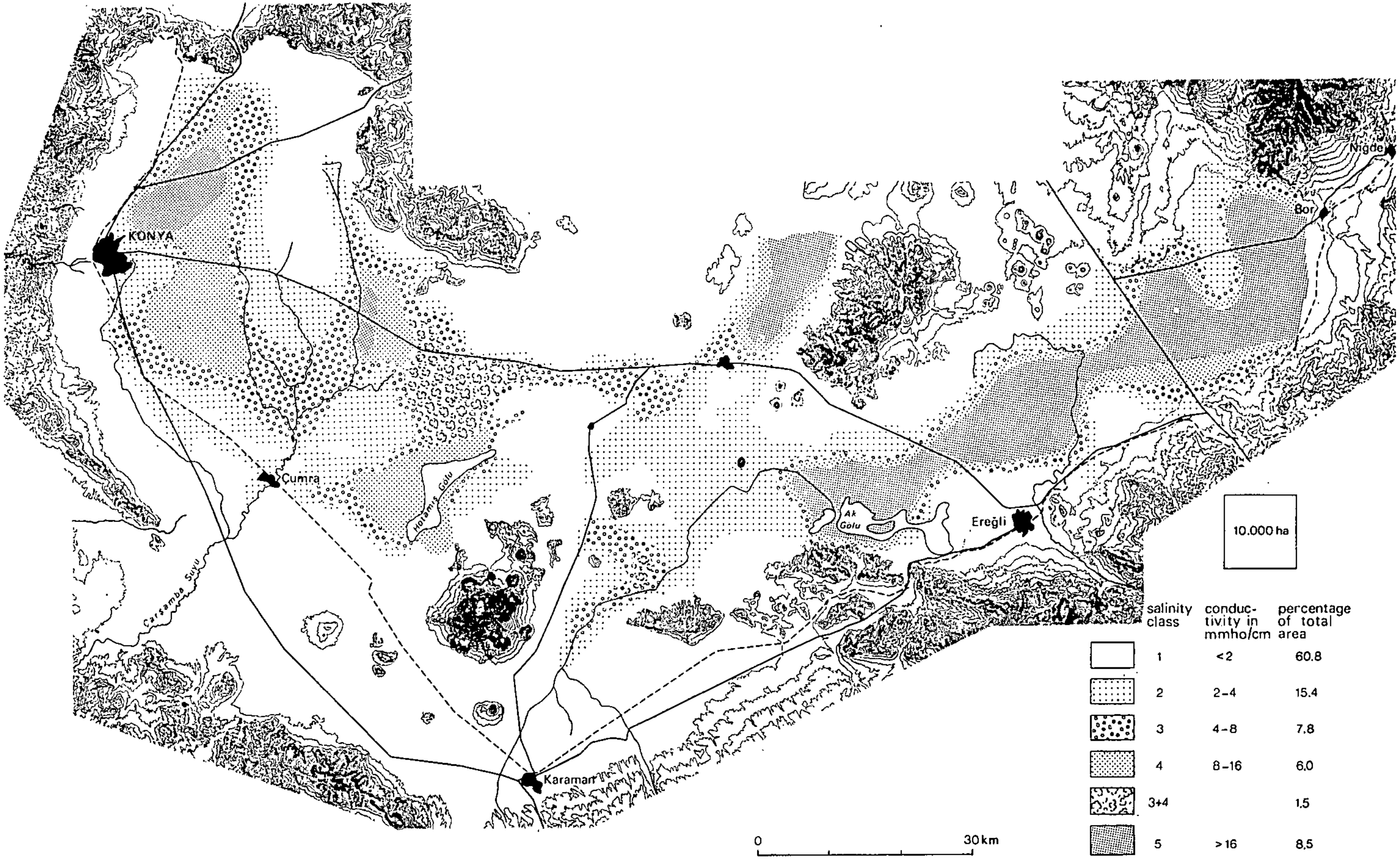
Area E consists mainly of marls. In the east it is fed by soak-away from the River Zanopa and by groundwater from Area D, in the west by a drainage canal from Karaman. In the south-west is a second fan of the Ayran which is irrigated and does not leave significant amounts of tail water. From the north some groundwater is supplied by streams from the uplands. The groundwater of this area disappears partly by evaporation and as result of drainage into deeper strata through Düden Göl, a doline. Presumably this doline had a much larger capacity in the past and may even have kept the lake level constant during sandridge formation (Louis, 1938).

Area F is a drainless subbasin, supplied from springs, mainly in the south and east. Little moisture could rise from the subsoil because the marls are here impermeable. In spring the area floods by discharge from the eastern uplands. The water disappears by evaporation mainly. Drainage is very poor.

6.3 Salinity

The lack of discharge from the Basin means that water is removed only by evaporation especially from the waterlogged centre. This evaporation induces salinization, especially if the salt content of the evaporation water is high, which is certainly true here. The groundwater flows towards the lower parts of the Basin through various salt-containing deposits. Marine sediments from the Upper Eocene, Oligocene and Miocene occur at several places in the centre. They were deposited either under arid conditions or in a lagune (see Chapter 2). Salt-containing volcanic material is found near Karapınar and in the north-east of the plain. Near Ereğli are deposits of almost

Fig. 67. Distribution of soil salinity in 5 grades in September 1967.



Şekil 67. Eylül 1965'te 5 derece içersinde toprak tuzluluğunun dağılımı.

pure gypsum.

Much salt enters the plain by the rivers and is partly distributed by irrigation canals and distributaries. The composition of the salts varies with the water's origin. Most common are Na_2SO_4, $NaCl$, $CaCl_2$, $MgCl_2$, $MgSO_4$ and $CaSO_4$. In volcanic areas nitrates are common as well.

Regional distribution The distribution of salts in the Basin is depicted in the salinity map (Fig. 67) in 5 grades according to average saturated extract conductivity of a soil profile at the end of the dry season. Only two classes are indicated on the soil map on the same basis. The depth of salt accumulation is not indicated in Fig. 69 despite its importance for agriculture. The map only gives the general salinity of the soil from observations at about 350 points all over the Basin.

The *external solonchaks* and shallow internal solonchaks occur in depressions or in the centre, where salts can be carried to the surface by capillary rise of groundwater, especially where the watertable is less than 1 m. Their occurrence is thus determined by hydrology, topography and physiography. They are common near the base of alluvial fans. Examples are near the Zanopa Fan, the May Fan and to a lesser extent north of Karaman. Here groundwater wells up when it reaches impermeable marls or heavy clays, below the permeable river fan material. The same process occurs north of Konya in the Aslım swamps where there are numerous wells and water from the western uplands seeps over the Marl Soils in the centre, which is strongly salt-affected through lack of drainage through underlying marl.

In irrigation areas, as north of Çumra, severely salt-affected soils border the irrigation and drainage canals from which seepage has caused salt accumulation in the topsoil. The canals provide a constant supply of water at only shallow depths, ideal for evaporation (Fig. 68B).

In general deeper *internal solonchaks* are nearer the border where the watertable is deeper and in impermeable Backswamp Soils. The depth and severity vary with watertable and salt content of the groundwater. If the salt accumulates more than 120 cm below the surface, the soil is considered non-saline. This was common on Terrace and Bajada Soils, and on Colluvial Slopes, especially those of volcanic origin, in these places conductivity was often more than 16 mmho/cm, which roughly corresponds to 1% salt, 150 cm deep, while the upper 120 cm was salt-free.

The Undulating Terraces, The Uplands and the upper parts of Bajadas and Alluvial Fans were free from salt (Fig. 68A).

Salinity types The terms salt-affected and saline are used to indicate an excess of salts in the soil profile. In fact however, almost all salt-affected soils are saline-alkali, i.e. they contain more than 15% exchangeable sodium. Non-saline alkali soils do not occur. The salt-affected soils in the Basin can be divided into various types.

Very common are *flooded solonchaks*, formed by evaporation of saline water standing in depressions. This saline water derives from seepage and run-off, and fills the depressions in spring. Thus strongly salt-affected areas are formed, which hardly

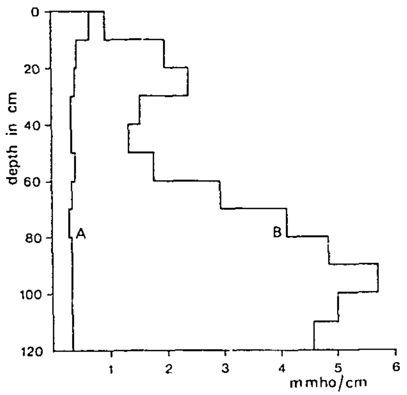
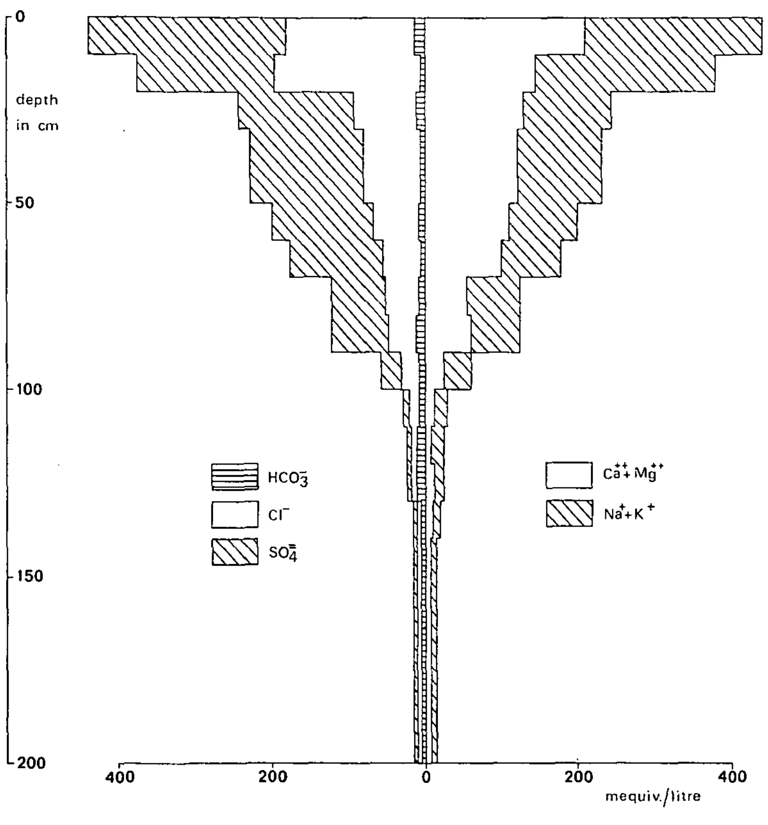


Fig. 68. Electric conductivity in 2 soil profiles near the top (A) and near the foot of an alluvial fan (B).

Şekil 68. Alluviyal yelpazenin (A) üst kısımlarında, (B) taban kısımlarında iki toprak profilinin elektriki geçirgenliği.

Fig. 69. Ion-balance of a saline soil in an external solonchak predominantly salinized by sulphate.



Şekil 69. Hakim olarak sulfatlar tarafından tuzlanan bir dış solonçaktaki tuzlu bir toprakta iyon dengesi.

bear any plant cover. They occur all over the central depressions, in particular east of Konya, north of Karapınar and in the area west of Ereğli.

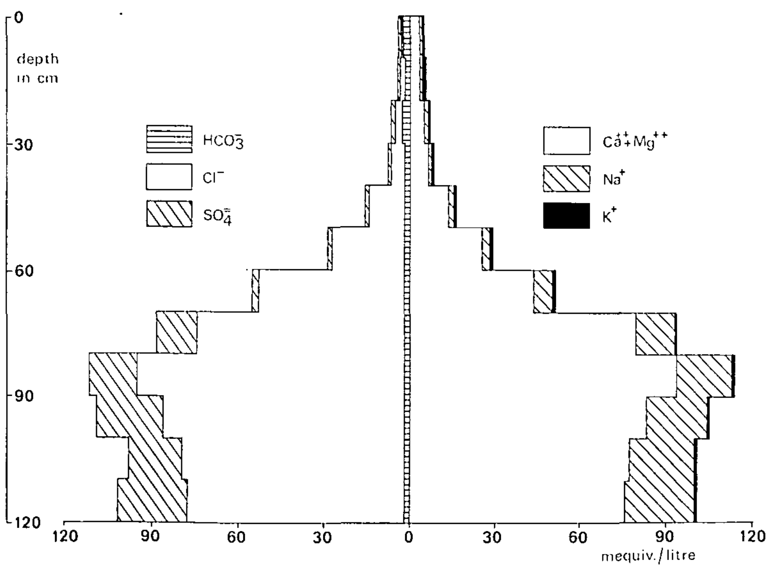
Another type of external solonchak is the *puffed solonchak.* It forms by accumulation in the top 10 cm of sodium sulphate, which is the most common salt in the Basin. These needle-shaped sodium sulphate crystals separate the soil particles, thus causing a fluffy top soil. Puffed solonchaks occur in several parts of the Basin. Examples were near Ak Göl, west of Dedemoğlu and near Konya. The latter contained almost pure magnesium sulphate with only traces of sodium.

Sabbakh soils are externally saline soils containing hygroscopic salts usually $CaCl_2$ and $MgCl_2$, as near Hortu. In the depression north of Karapınar the hygroscopic salt is locally $NaNO_3$, originating from an area with former volcanic activity south and west of Karapınar. The hygroscopic salt attracts moisture vapour during the night when air humidity is relatively high. The salt crystals dissolve and form a muddy surface.

Many kinds of efflorescence were observed in the Konya Basin varying from glassy thin surface crusts to loose porous layers of salt up to 7 cm thick. They are all found at places with watertables less than 1 m.

Agriculturally electrical conductivity values of 8, corresponding to salt percentages of 0.15 to 0.35%, are tolerable for most crops. Not all salts are equally harmful. Crop yields are depressed most by sodium salts, chlorides and sulphates, except for calcium

Fig. 70. Ion-balance of a saline soil and its groundwater in an internal solonchak predominantly salinized by chloride. Profile near Karkin, Çumra Area.



Şekil 70. Hakim olarak klörürler farafından tuzlanan bir iç solonçaktaki tuzlu toprakta ve taban suyunda iyon dengesi. Çumra bölgesi, karkın yakınlarındaki profil.

sulphate (gypsum) which is not very soluble (up to 30 g/litre) unless accompanied by sodium salts of chlorides. Most of the salts in the Basin are sulphates, followed by chlorides and bicarbonates (Fig. 69). Sodium sulphate and chloride are especially common (Fig. 70), while magnesium salts predominate locally, as near Konya.

6.4 Reclamation of saline soils

See also Van Beek & Driessen and Peters in Part B.

Much of the Basin could be profitably improved. A difficulty is the poor drainage, which could hardly be improved without increasing salinization elsewhere.

Since plan growth is stunted if the soil contains excess soluble salts, the amount of salt must first be reduced and then kept at an acceptably low level.

The excess of irrigation water needed to leach the salt is usually estimated from pilot schemes or models. Such trials take time. The excess can, however, be roughly predicted by calculation. Two methods will be used here to demonstrate the influence of hydrology and climate on salinization in the Çumra Area as depicted in Profile 26 (Fig. 37). In September 1964, after the dry season, this profile showed a peak of 0.80% salt at a depth of 20–30 cm. In winter, the rainfall leaches this salt completely or partly, to deeper layers. Van der Molen (1956) developed a mathematical description of this movement from a theory originally developed for chromatography. Like all mathematical approximations, it cannot consider all factors in such a complicated system and therefore gives only a rough impression of what really happens. The theory predicts that, with a salt concentration c in g per 100 g dry matter,

$$c = \frac{c_0}{2} \left[\operatorname{erfc} \frac{p-1}{\sqrt{2p}} \sqrt{N} - e^{2N} \operatorname{erfc} \frac{p+1}{\sqrt{2p}} \sqrt{N} \right]$$

in which

erfc = error function complement

p = v/(0.014Ad)

N = d/2k

c_0 = salt concentration before leaching

v = mm rain/cm^2 infiltrating the soil (assumed to be saltfree)

A = moisture content of the soil in ml/100 g dry matter

d = depth in the profile

$2k$ = thickness of the horizontal layers, into which the profile is divided for the calculation

$$\operatorname{erfc} n = 1 - \frac{2}{\sqrt{\pi}} \int_0^n e^{-u^2} \, du$$

The calculations assume even infiltration of the rain through the soil. In the swelling clays which cover some parts of the plain, the rain will initially run through the cracks and later run off the surface to lower parts, so the calculation becomes inaccurate. For Profile 26 a total supply of 200 mm rainfall gave a calculated peak of 0.45% salt at a depth of 35 cm.

To keep salt low, excess irrigation water is needed, which can be removed by an adequate drainage system. To calculate this excess a combination of the salt and water balance can be used (Dieleman, 1963). From this combination it appears that

$$p = (ET - N)c_i/f(c_{sm} - c_i)$$

in which

p = excess irrigationwater, to be dιained
ET = evapotranspiration
N = precipitation
f = leaching efficiency
c_i = conductivity of the irrigationwater in mmho/cm
c_{sm} = conductivity of the soil moisture in mmho/cm

The leaching efficiency f is an experimentally determined factor, which varies from 0 to 1 according to soil permeability and composition of the salts.

Consumptive uses were calculated by Mr Saban Ermis, Director of the Experimental Station at Çumra for the period April to October by the method of Blany & Criddle: sweet clover 1164 mm, sugar-beet 874 mm and fruit-trees 934 mm. The efficiency of the irrigation water was assumed to be 70%. Locally, efficiencies may be much lower down to 10%. Over the period the rainfall is about 91 mm. The conductivity of Çarşamba irrigation water was about 0.4 mmho/cm; the chosen admissible conductivity of soil moisture is 4 mmho/cm.

In summary, the following data are assumed:

f = 0.50
CU = 1000 mm/April–October
N = 90 mm/April–October
c_{sm} = 4 mmho/cm
c_i = 0.4 mmho/cm

Thus

$$p = (1000 - 90)0.4/(4 - 0.4)0.5 = 202 \text{ mm}/214 \text{ days.}$$

Since the amount of irrigation water to be supplied (I)

$$= CU + p - N$$

a supply of (1000 + 202 — 90) = 1112 mm water is necessary over the period April to October. This is about 5 mm/day of which about 1 mm must be removed by the drainage system.

In a flat area like the Konya Plain this creates problems. If the drainage system is inadequate, the watertable rises in other parts of the plain which will quickly become saline by evaporation of capillary water. The minimum permissible watertable, called critical depth, has been studied for many years. The following formula was proposed by Polynov, a Russian soil-scientist (See Janitzky, 1957):

$y = 170 + 8x \mp 15)$cm

in which

y = critical depth

x = average temperature in °C.

From the average meteorological data from the Basin a critical depth of 262 $\pm$ 15 cm can be considered safe (Fig. 71). Other authors (Talsma, 1963) allow a greater tolerance and base their opinion on the consideration that the capillary rise of the groundwater can rarely equal evapotranspiration.

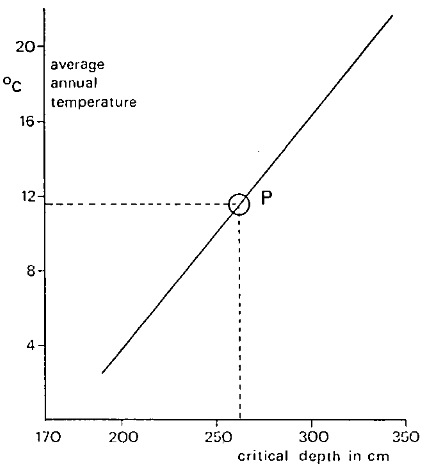


Fig. 71. Critical watertable-depth in relation to average annual temperature. Point P indicates the situation in the Çumra Area.

Şekil 71. Ortalama senelik sıcaklığa bağlı olarak kritik tabansuyu derinliği. P noktası Çumra bölgesindeki yerini işaret etmektedir.

7 Soil fertility

by B. H. Janssen

7.1 The field trials

In its widest sense soil fertility covers the ability of a soil to grow crops, but will here be limited to its ability to provide the plant with nutrients. This was tested in 1967 and 1968 in NPK fertilizer trials on particular soil units of agricultural value if their area merited consideration. The methods and results will be described more fully in Janssen (1970).

Irrigated crops were excluded because they represent such a small proportion of the Basin, because the Turkish experimental stations have already completed many trials on these irrigated alluvial soils and because the irregularities of irrigation and drainage systems under the farmer's control make the trials uneven.

A wheat-fallow rotation was the rule but in 1968 rye was also tested because of the poor yields of wheat on some soils. In the 2 seasons 15 and 14 trials were laid out on Terraces TeB (3), TeC (2) and ThA (2), Bajadas BrA (8), BrB (3) and Marl Soils LmA (7) and LmC (3). One field in Unit BrA was lost because a farmer harvested it by mistake. Two fields of Unit LmC were destroyed by flooding. A field on the Colluvial Slopes was transitional to the Bajadas BrB and is discussed with them. For position of trials see Fig. 72.

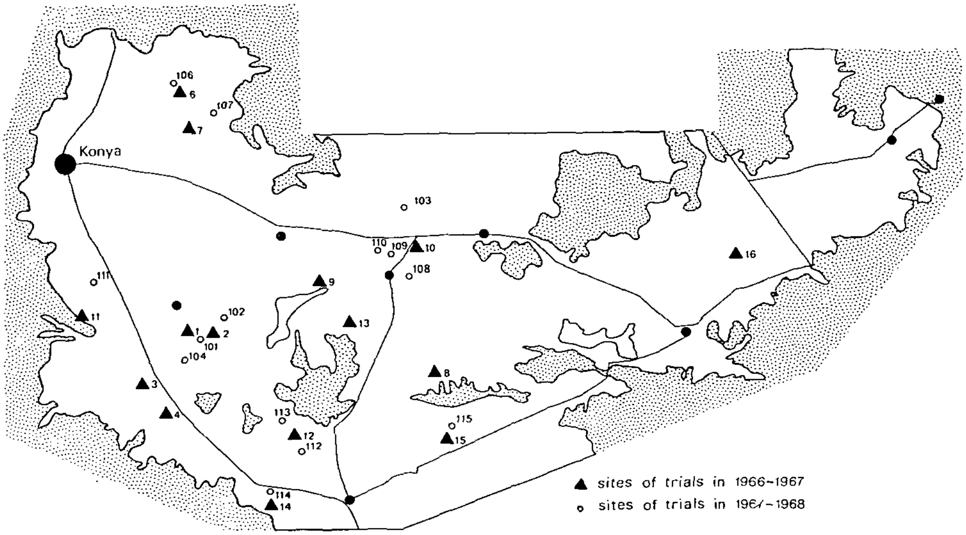
Work on fertilizers for wheat and rye in Turkey has so far been done only on the major elements. The soils of Central Anatolia are rich in potassium and poor in phosphorus (Çagatay, 1961; Yurtsever, 1964). Only rarely has a significant response to nitrogen been found where the soil is moist in spring (Yılı, 1958–9; 1960–2).

Bearing these facts in mind, the trial in the first season was a factorial with 0, 30 and 60 kg N per ha and 0, 40 and 80 kg P_2O_5 per ha in triplicate. Each replicate has a plot with N 60, P_2O_5 80 and K_2O 60 kg per ha to check any possible influence of potassium.

In the second season 4 × 4 factorial trials were used with 0, 40, 80 and 120 kg P_2O_5 per ha on all fields, 0, 30, 60 and 90 kg N per ha on the Bajadas and 0, 20, 40 and 60 kg N per ha on the other soils.

The fertilizers used were: ammonium sulphate (21 % N), chosen because of its acidity and because NH_4^+ is leached less in winter than NO_3^-; triple superphosphate (43 % P_2O_5), which like superphosphate gives a better response than other phosphates on soils of such a high pH; potassium chloride (60 % K_2O). The last two were rich in the nutrient element, thus limiting the amount of salts added to the soil. All fertilizers were banded 10 cm deep between drills 18 cm apart during sowing in October. Seed was placed 3 cm deep. Seed and fertilizers were kindly provided by Toprak ve Gübre

Fig. 72. Position of fertilizer trials.



Şekil 72. Gübre denemelerinin yerleri.

Fig. 73. Weighing of plot yields (grain and straw) in the field.

Şekil 73. Plot mahsüllerin tarlada tartımı (tane ve sap).

Araştırma Enstitüsü (Soil and Fertilizer Research Institute), Ankara.

Stages of development were recorded in May for correlation with yield. In July yield of grain and straw was measured (Fig. 73) and about 10% was threshed by hand (Fig. 74) to find the ratio of grain to straw and thus calculate the yield of grain. To find causes of yield differences, 1000-grain weight was measured and where possible number of ears and of grains per ear were calculated.

Soils from the field trials and various other areas were taken for brief pot trials by a modification of Bouma's method (1962, 1966, 1967) in June–July 1968 at Çumra and in 1969 at Wageningen. Their purpose is to find whether the field trials can be restricted in future surveys.

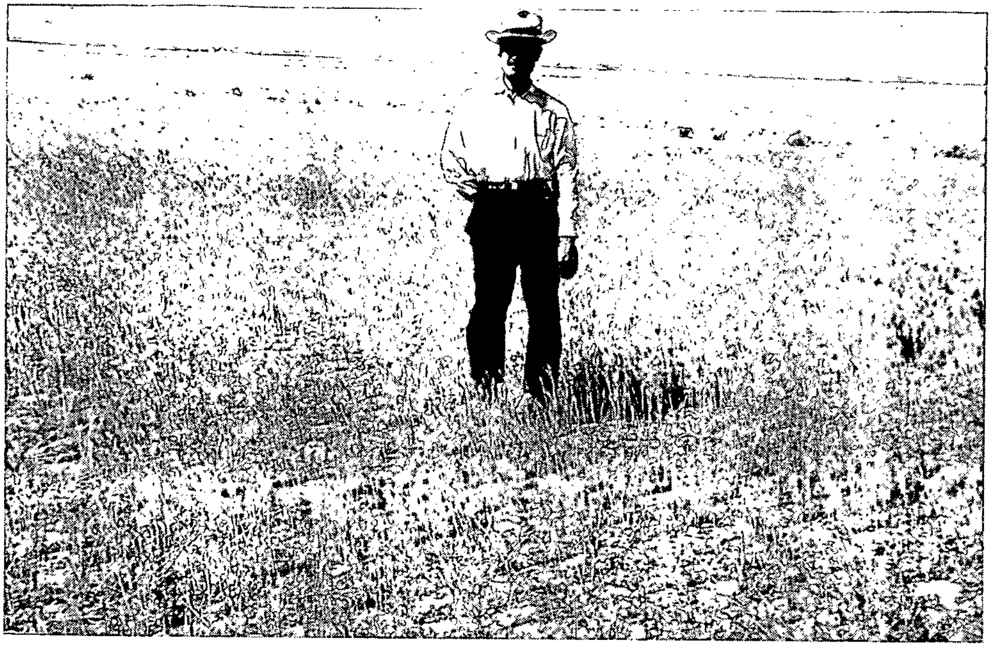
Soil moisture was estimated at least three times during the field trials: at sowing, in May and at harvest. In 1966 and 1967 the top 120 cm was sampled and in 1968 the top 200 cm, where possible. Some estimates of water conservation during the fallow year and of changes in moisture content during growing season are described in Part B.

The soils are being analysed for texture, organic matter, $CaCO_3$, pH, available P_2O_5, ECe, volume weight and pF. A profile from each field has been described. About 2000 samples of grain and straw will be analysed for N and P to estimate how much the crop removes from the soil.

Fig. 74. Threshing of plot yields by hand.

Şekil 74. Plot mahsullerin elle harmanı.

Fig. 75. A. Fertilizer trial on unit LmA (near Akçaşehir). Yield 300 to 550 kg per ha grain.
B. Same stage of growth on Unit BrB (near Bulgurluk). Yield 1480 to 2840 kg per ha grain.



Şekil 75. A. LmA ünitesinde gübreleme denemesi (Akçaşehir yakınları). Mahsul dönüme tane olarak 200–500 kg dır.

B. BrB ünitesinde ayni yetişme durumunda (Bulgurluk yakınları). Mahsu hektara tane olarak 1480 ile 2840 kg arasındadır.

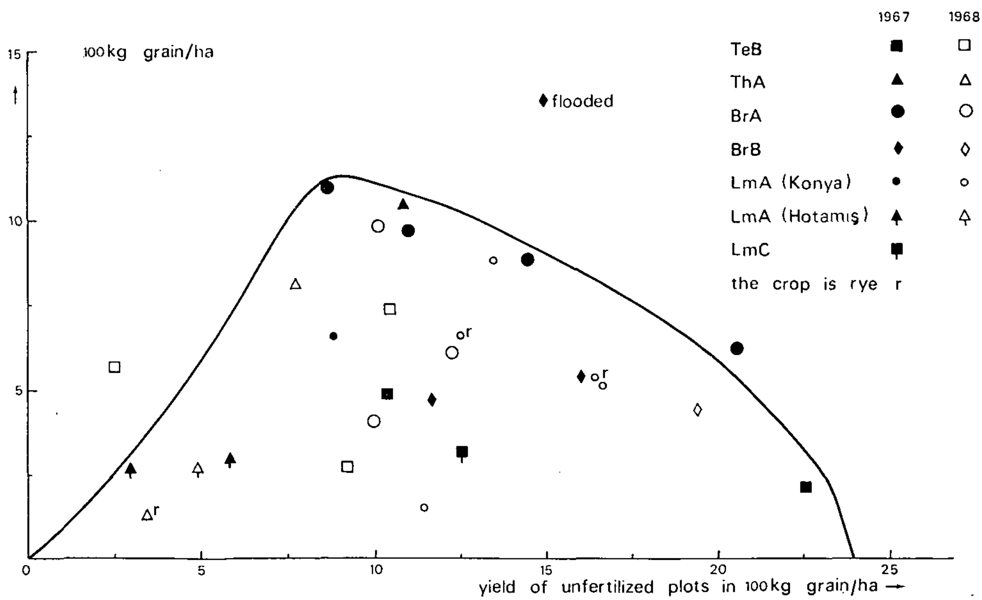
7.2 Preliminary conclusions

The results have not yet been analysed statistically so that conclusions, especially from the second season, should be treated with reserve.

Yields differed between fields and with fertilizer (Fig. 75). Fig. 76 plots the highest yield increment in each field against the yield of unfertilized control plots. In control plots yielding less than 700 kg grain per ha, fertilizer could not increase yield to an acceptable level. If control yields were between 700 and 1500 kg per ha, fertilizers were most likely to be effective in increasing the yield. If yield was more than 1500 kg per ha, fertilizer had little effect; probably moisture became limiting. The highest yielding plots were not always those with most fertilizer; here again growth was probably limited by drought.

Table 23 lists yields from the highest yielding plots in field trials according to soil type. The higher precipitation and watertables near Konya than near Hotamış may explain the difference in yield between areas on the Unit LmA (e.g. Tömek and Hotamış). Higher rainfall in 1967 would have caused the higher yields on the Bajada and Terrace soils and would have contributed to the greater response to nitrogen than in 1968 (Fig. 77A). Again Konya Area was an exception. See also Janssen, Part B.

Fig. 76. Highest yield increment (ordinate) of each field plotted against yields of unfertilized fields. The crop is wheat.



Şekil 76. Gübresiz tarlalardan elde edilen mahsullerin her tarla için en yüksek mahsul artışına karşı noktalarla işaret edilmesi. Mahsul buğdaydır.

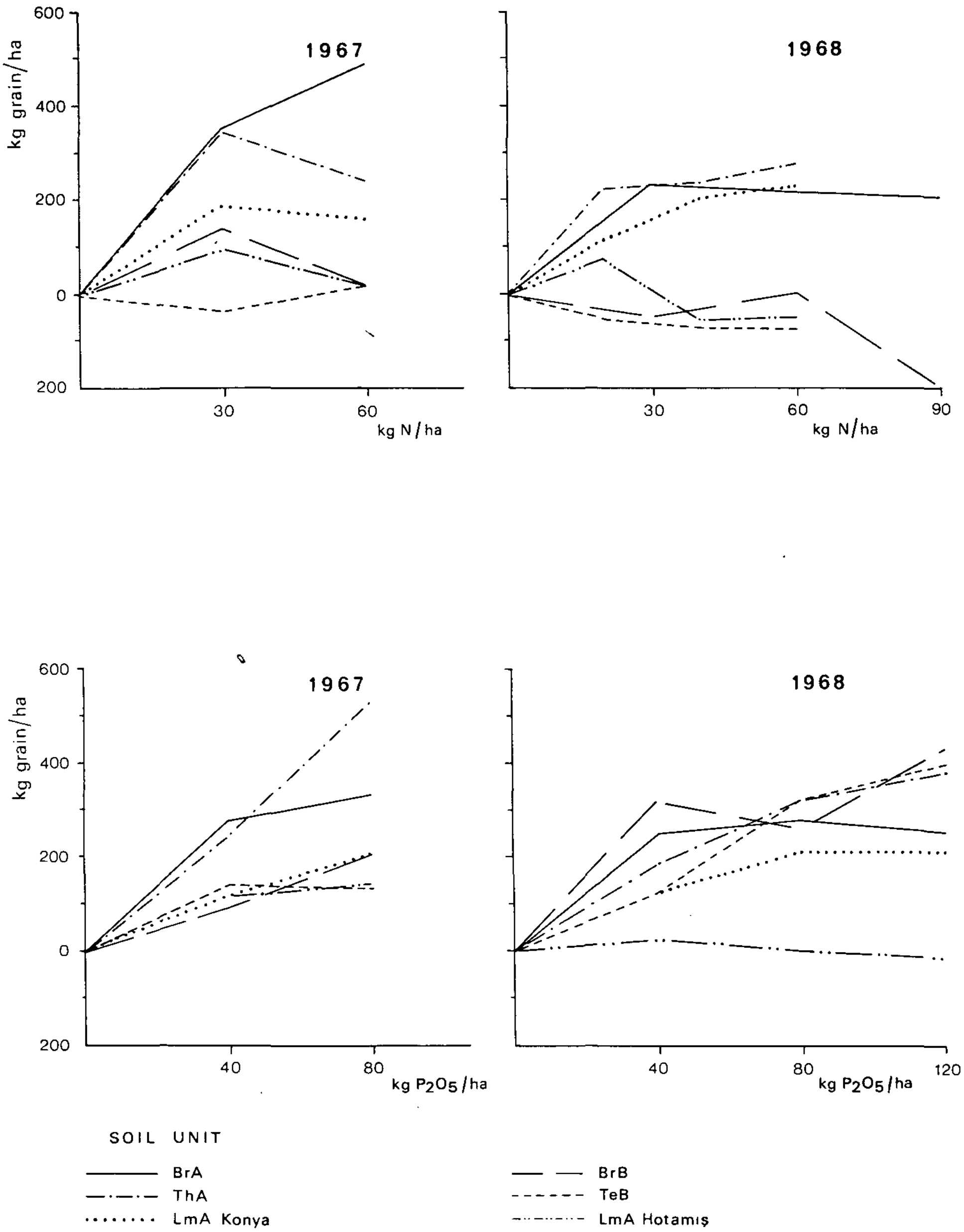
Table 23. Yields of wheat from highest yielding plots in the field trials in 1967 and 1968 (in kg/ha)

1967		1968		
Te Terrace soil				
Okçu	2462	Okçu		798
Türkmençamili	1513	Türkmençamili		1761
		Demiryalı		1181
Average	*1988*			*1247*
ThA Undulating Terrace				
Kızılkuyu	*2120*	İnliköy		*1578*
BrA Reddish-brown Bajada				
Yayla	*2668*	Eminler		1397
Seçmeköy	1834	Mandosun		1762
Eminler	1945	İllistra		1980
Average	*2189*			*1713*
BrB Brown Bajada				
Eğilmez	1618	Sudurağı		2365
Sudurağı	2130			
Average	*1874*			*2365*
BrD Dissected gravelly				
Burgurluk	*2838* (has been flooded in spring)			
LmA Marl Soils of the Konya Area			*wheat*	*rye*
Tömek	1530	Tömek	2223	2203
Ortakonak	1293	Zinçirli	2216	1903
Average	*1412*		*2220*	*2053*
LmA Marl Soils of the Hotamış Area				
Akçaşehir	556	Hotamış	775	463
Kamisağıl	876			
Average	*716*			
LmC Marl Soils with dark-gray organic surface soil				
Büyükaslama	*1559*			

Tablo 23. 1967 ve 1968 deki en yüksek mahsul plotlarından tarla denemelerinden elde edilen mahsuller.

In both years Reddish-Brown Bajada (BrA), Undulating Terrace (Th), and Konya Marl (LmA) could be distinguished from brown Bajada (BrB), Terrace (Te) and Hotamış Marl (LmA) by the obvious response to nitrogen in the first group but not in the second. Probably the first group of soils responds more because it contains a smaller amount of available nitrogen and holds more moisture. The second group may respond less because there is insufficient water to meet the plant's increased demand created by encouragement of growth with nitrogen. In several places, however, the effect of nitrogen was small or negative only when the level of phosphorus was low, so

Fig. 77. Average yield increment. Above: with nitrogen fertilizer. Below: with phosphorus fertilizer.



Şekil 77. Ortalama mahsul artışı.
A. Azotlu gübrelerle.
B. Fosforlu gübrelerle.

that nitrogen applied without phosphorus may upset the nitrogen-phosphorus ratio in the plants. Further analyses and pot trials may clarify the problem.

Except for Marl Soil of the Hotamış Area in the second year, all types responded to phosphorus (Fig. 77B). Response in 1967 was greater on Reddish-Brown Bajada, Dissected Terrace and Marl of Hotamış Area, and was less on Brown Bajada and Terrace than in 1968. On Marl of the Konya Area the response was the same in both years. Variation between soil types was less for response to phosphorus than to nitrogen, probably because available phosphorus was low, P. Olsen 4 kg per dekar or less (Yurtsever, 1965) and because crops adequately supplied with phosphorus are more drought-resistant because of increased root growth, masking the differences in moisture holding capacity.

Economically optimum fertilizer rates cannot be deduced from Figs. 79A and B, but will be calculated for each trial. So far it seems that nitrogen (20–40 kg N per ha) must be applied only to the Reddish Brown Bajadas, the Marl Soils of the Konya Area and the deeper soils of the Undulating Terraces. Phosphorus (40–60 kg P_2O_5 per ha) seems beneficial on all soil types except Marl Soil of the Hotamış Area where any fertilizer is hazardous, because other factors limit growth.

8 Taxonomic soil classification

8.1 Introduction

'A taxonomic unit is a creation in the mind of man to facilitate his thought about objects in numbers so great that he cannot comprehend them individually' (Soil Survey Manual, 1951, p. 277).

Reconnaissance surveys cannot use any particular grade of taxonomic unit. Instead 'Mapping units' are erected, usually representing more than one taxonomic unit and including inevitable transitions and deviations. Section 4.2 explains how the mapping units of the Basin are grouped into soil associations and those in turn into broad soil associations or landscapes.

Because a taxonomic classification of respresentative profiles of the mapped soils is scientifically desirable, many countries have designed national taxonomic systems, as exist in Turkey and the Netherlands. But in this soil study, preference is given to the United States Department of Agriculture's new classification system (Soil classification, 1960), because of its wide international acceptance. This 7th Approximation has been kept under revision with supplements in 1964 and in 1967. The definitive version is expected to be published in due course.

The representative profiles included in the descriptions of mapping units have all been classified according to the 1964 and 1967 Supplement, wherever our data were sufficient.

8.2 Soil genesis and diagnostic horizons

In the unit descriptions and the representative profiles of Chapter 5 ample information is given on soil structure, texture, soil horizons and the occurrence of special horizons of calcium, gypsum or salt accumulation. A short review of soil-genetic (pedogenetic) features is given below.

The soils of the Great Konya Basin consist mainly of recent deposits. The Alluvial Plains, the Lacustrine Plains, the Marshes and the Aeolian Sandplain are all of late Pleistocene or Holocene age. Soil genesis is limited to moderate or weak A–B–C zonation and the occurrence of zones with slight accumulation of calcium carbonate and gypsum. Moderately or severely salt-affected areas have internal and external horizons with salt efflorescense. The Backswamp Soils have the characteristic features of swelling clays: parallelepipedal structural elements, slickensides, deep cracks and a surface mulch of soil aggregates. The water-logged soils (mainly marshes) exhibit severe gleying.

The Terraces, the Colluvial Slopes, the Bajadas and the Old Sandplain are mainly Neogene or Pleistocene and show much more pronounced signs of soil genesis, such as an illuvial B-horizon (sometimes with clay coatings) and zones with a heavy accumulation of calcium carbonate or gypsum. Hardpans of lime or silica occur locally.

The new USDA classification is based largely on well defined diagnostic horizons. Some characteristics of these horizons are given below.

A *mollic epipedon* has a surface mineral layer whose structure is not hard or very hard when dry. It is moderately dark (value 3.5–5.5 according to moistness and chroma 4 or less when moist), base saturation is over 50% by the ammonium acetate method; organic carbon is at least 0.58%; it has certain thickness and less than 250 ppm P_2O_5 soluble in citric acid.

A *histic epipedon* is saturated with water at some season and is very rich in organic carbon.

An *umbric epipedon* looks like a mollic epipedon but the dominant exchangeable cation is hydrogen.

An *ochric epipedon* is too light in colour, too high in chroma, too low in organic carbon or too thin to be mollic umbric, anthropic or histic.

An *argillic horizon* is an illuvial horizon in which layer silicate clays have accumulated to a significant extent. It therefore must be formed below the surface of the mineral soil, though it may later be exposed by erosion.

A *cambic horizon* is an altered horizon having a texture finer than loamy fine sand. The alteration is produced by chemical changes and movement of the particles as by frost, roots and animals, enough to destroy most of the original rock structure including fine stratification of silt, clay and sand in alluvial or lacustrine deposits. It is normally in the position of a B-horizon but may reach the surface in truncated profiles.

The following pans and other horizons occur:

Duripans are hard layers cemented in part by an agent presumably silica, soluble in concentrated alkali but may also be partly calcium carbonate and often iron oxides. They grade into petrocalcic horizons of semi-arid and arid climates, into fragipans of humid climates and into non-cemented earthy horizons.

A *fragipan* is loamy with little organic matter and of high density relative to the solum above. It is cemented when dry but brittle when moist.

A *natric horizon* is a special type of argillic horizon with prismatic or columnar structure and more than 15% saturation with exchangeable sodium.

A *calcic horizon* is a horizon of secondary carbonate enrichment of defined concentration.

A *gypsic horizon* has secondary calcium sulfate enrichment of defined concentration.

A *salic horizon* has a defined concentration of secondary salts more soluble in water than gypsum.

Table 24. Review of representative profiles and their taxonomic classification, according the 7-th Approximation, Supplement 1967.

Profile No.	Taxonomic classification Suborders	Mapping unit	Soil Association
1	Typic Calciorthid	Te A	Flat Terrace Soils
2	Typic Paleorthid	Te A	,,
3	Mollic Calciorthid	Te A	,,
4	Typic Durorthid	Te B	,,
5	Typic Calciorthid	Te C	,,
6	Typic Xerorthent	Te C	,,
7	Andic Calciorthid	Te D	,,
8	Typic Calciorthid	ThA	Undulating Terrace Soils
9	Lithic Xerorthent	Th A	,,
10	Aquic Xerorthent	Tc A	Soft Lime Soils
11	Salorthidic Xerorthent	Tc A	,,
12	Thapto Vertic Haplic Haplargid	Br A	Limestone Bajada Soils
13	(Vertic) Xerorthent	Br A	,,
14	Typic Calciorthid	Br B	,,
15	Typic Camborthid	Br B	,,
16	Typic Calciorthid	Br D	,,
17	Typic Chromoxerert	Bv A	Volcanic Bajada Soils
18	Typic Calciorthid	Bv A	,,
19	Andic Durorthid	Bv B	,,
20	Andic Calciorthid	Bv C	,,
21	Typic Xerochrept	Aa A	Çamurluk Fan Soils
22	Entic Chromoxerert	AbA	Former Backswamp Soils
23	Entic Chromoxerert	Ab B	,,
24	Typic Haplaquept	Ab D	,,
25	Typic Calciorthid	Ab E	,,
26	Typic Calciorthid	Ac A	Çarşamba Fan Soils
27	Typic Calciorthid	Ac C	,,
28	Typic Haplargid	AdA	Deli Fan Soils
29	Typic Haplargid	Ae A	Selereki Fan Soils
30	Typic Haplargid	Ae B	,,
31	Typic Xerorthent	Af A	Çakmak Fan Soils
32	Typic Camborthid	Ag A	Zanopa Fan Soils
33	Typic Durorthid	Ah A	Bor Fan Soils
34	Typic Camborthid	Ak A	Meram and Sille Fan Soils
35	Typic Xerochrept	Am A	May Fan Soils
36	Typic Calciorthid	As A	Ayran Fan Soil
37	Aquic Calciorthid	Lm A	Marl Soils
38	Aquic Calciorthid	Lm A	,,
39	Salic Calciorthid	Lm B	,,
40	Aquic Calciorthid	Lm C	,,
41	Aquic Natrargid	Lm D	,,
42	Salic Calciorthid	Lm F	,,
43	Salic Calcixeroll	Lr A	Sandridge Soils
44	Salic Calcixeroll	Lp A	Sandplain and Beach Soils
45	Stratic Camborthid	Lp B	,,
46	Entic Vitrandept	Lp C	,,
47	Typic Haplaquent	Mf C	Marsh Soils
48	no profile development	Dd A	Sand Dunes

Tablo 24. Profillerin yeniden gözden geçirilmesi ve bunların 7'inci tahmin'in 1967 deki ilavesine göre taksonomik sınıflandırılması.

8.3 Major taxa of the Basin

Orders and suborders represented are:

Entisols, soils without definite horizons. In the Basin they include: *Psamments* which have loamy coarse sand or coarser material between the Ap horizon or 25 cm, whichever is deeper, and 100 cm or rock, whichever is shallower; *Orthents* with loamy fine sand or finer in at least part of the layer.

Vertisols are rich in expanding lattice clay (Smectite group) which readily cracks into wedge-shaped or parallelepipedal aggregates. The are represented only by Xererts with chromas more than 1.5 in the top 30 cm but without distinct mottling in the top 75 cm.

Inceptisols are young soils with diagnostic horizons but without significant illuviation, eluviation or weathering. They are represented by: *Aquepts* with a histic or ochric epipedon, more than 15% Na in the upper 50 cm or characteristic colours or mottles through gleying; *Ochrepts* with a thin A1 or Ap horizon resting on a cambic horizon; Umbrepts with little, if any, allophane or volcanic ash and with umbric epipedon at least 25 cm thick.

Aridsols are arid soils with an ochric epipedon and cambic, argillic, natric, calcic, gypsic or salic horizons, or a duripan. They are represented by: *Orthids* without an argillic or natric horizon but whose saturated extract may be more conductive than 2 mmho per cm at 25°C unless a calcareous epipedon rests directly on a calcic horizon and may have a calcic, gypsic or cambic horizon, or a duripan in the top 1 metre; *Argids* with an argillic or natric horizon.

Mollisols are some of the soils with a mollic epipedon. They are present only as an *Aquoll* without an albic horizon but strongly hydromorphic and an *Ustoll* with a chroma of 2 or more.

Great groups within the suborders are formed by prefixing names of characteristic properties or horizons, e.g. a Pelloxerert is a dark xerert, a Histaquept contains a histic horizon. Subgroups of great groups are preceded by the adjectives Typic if the subgroup is thought to typify the central concept of the great group.

If the aberrant property of a soil is one which is characteristic of another suborder great group or subgroup in the same suborder, the deviation (intergrade) is indicated respectively by adjectives like *Entic*, *Aqueptic* or *Andic*.

Other soils outside the range of typic subgroups, representing deviations from the central concept ('extragrades') are preceded by the following adjectives:

Andic, much volcanic ash, pumice or amorphous clay.

Lithic, a lithic (rock) contact near the surface, soil depth less than 50 cm.

Aquic, part or present gleying indicated by colour and mottling.

No attempt has been made to express the nature of the mapping units in terms of the new US classification system (Soil classification 1960), but on Table 24 a review is given of the representative profiles of Chapter 5 and their classification according the Supplements of 1964 and 1967.

9 Soil suitability for agriculture

9.1 Soil-survey interpretation

A soil-survey provides fundamental information about soil characteristics. The information may be used for a variety of practical purposes, such as agriculture, town planning or recreation. They all involve interpretation of the data.

For agriculture local factors, economic, social and technical, will influence the productivity possible from any unit. Various classifications have been erected for the interpretation of soil data. The most widely known are those of the United States Soil Conservation Service and of the United States Bureau of Reclamation, which have been used by the Turkish authorities. They are adapted to the highly sophisticated agriculture of North America. It seems better here to work from first principles along the lines suggested by Bennema (1964) for Brazil. Unfortunately we could hardly take into account local economic and social factors which seem extremely complex. After listing soil properties and other information of direct interest, each has been examined to see how it is deficient and whether it can be improved. A classification has then been erected based not only on the prevalent farming system but also on two others that are feasible. We have taken 9 properties of the soil, 5 ways in which agriculture may be limited, and thereby considered the capability on the mapping units for 3 management systems (Table 25).

Data pertinent to soil-use

Of all inherent soil properties and other data recorded on the Soil Map and in the descriptions of Chapter 5, there are several which in particular are pertinent to agricultural use of soils. Those data are summarized in Table 25 as a basis for further evaluation of the unit. A review and the terminology is given below:

1. *Area* occupied by the mapping unit and its percentage of the total area indicates its importance.

2. *Parent material* is in the Basin almost the same as the soil material. Among them are limestone, volcanic rock, limestone colluvium, volcanic colluvium, bajada clay or loam, alluvial clay or loam, carbonatic clay, loam or sand and soft lime. Except for the carbonatic materials with 40–60% and the soft lime with about 90%, they all contain 15–40% carbonates measured as $CaCO_3$. (Chapter 4).

3. *Effective soil depth* is a measure of how deep roots can penetrate the soil. Besides bedrock and hardpans, it may be limited by calcic horizons and poor soil structure.

The usual scale is very shallow, moderately deep, deep and very deep. (Chapter 4).

4. *Texture of the surface soil*, alongside depth, governs the availability of moisture, oxygen and nutrients to the roots. The simplified scale is sandy, loamy and clayey, with indication of stoniness if necessary.

5. *Water supply* is expressed in terms of drainage class in the scale very poor, poor, imperfect, moderately good, somewhat excessive and excessive (Soil Survey 1951, p. 170) and in terms of frequency of inundation in the scale occasional (once in more than 5 years), frequent (once in 2–5 years) and annual.

6. *Salinity* is ignored in the map legend except for units LmD and LmE. Elsewhere it is indicated by symbols. Salt-affected soils can be improved by leaching unless they are too low-lying to be drained and then will always remain in Suitability Class IVa or IVb. The scale is salt-free, slightly affected, moderately affected, strongly affected (*op. cit.*, p. 357).

7. *Slope* is expressed in the scale: level, nearly level, gently sloping, moderately sloping and steep (*op. cit.*, p. 162).

8. *Permeability* data are scarce but are considered where known. The scale expressed for the surface soil (down to 50 cm) and the subsoil (50–120 cm) is very slow, slow, moderate and rapid.

9. *Other data* are not included in Table 25 because they vary within the Basin. *Erosion* is of little importance except near the border and in sandy areas. Organic carbon is normally too little to affect the base-exchange capacity, which varies between 10 and 25. pH values are unusually high, between 7.5 and 8.5.

Agricultural status of soils

The suitability of soils for agriculture may be classified against a hypothetical ideal soil without nutrient deficiency and without toxic salts, favourable in structure, with ample water and oxygen, not liable to be flooded, and suitable for all agricultural machinery. For each of these characteristics the actual soils may have deficiencies or impediments which are given in the Table as *slight deviation* (including those with no marked defect), *moderate deviation* and *severe deviation*. Each may depend on more than one soil property.

Nutrient status depends on the availability of major and trace nutrients and is limited by the presence of toxic salts. Exact data are available only for some of the important mapping units (Chapter 7) and information elsewhere is based only on general observations. Availability depends on depth, biological activity, deficiency of oxygen or moisture, pH and cation exchange capacity.

Soil structure may inhibit growth of plants, even when oxygen and moisture are adequate. The entire 'structural profile' has to be considered. In the root zone a granular and subangular-blocky structure with pores of all sizes seems favourable, whereas an angular-blocky, a prismatic or a platy structure with pores mainly of one size seems bad. A dense plough layer, susceptibility to puddling after rain and a markedly impervious surface soil may impede rooting and germination.

Moisture deficiency prevails except in irrigated areas but its extent varies from year to year with variability in the seasonal rains. In well drained soils the storage capacity is important and depends on depth of rooting zone, on texture, type of clay and the carbon content. Poorly drained soils are affected by the accumulation of toxic salts. A few colluvial soils profit from run-off from the uplands. Our information on water deficiency in unirrigated soils is based on field observations.

Oxygen status is inversely related to moisture status, which is in turn related to drainage, climate, relief and soil properties such as permeability. Floods may cause temporary lack of oxygen as well as mechanical damage. All the same they are best considered separately because a soil deficient of moisture in the dry season may have too much in the wet season. However a very dry soil will never be more than slightly deficient of oxygen.

Suitability for agricultural machinery depends on slope, stoniness or rockiness, shallowness including the presence of horizons unsuitable for ploughing, drainage and extreme mechanical properties as in smectite-type clays or loose sandy soils. Microrelief such as sand hummocks or clay dunes may form another impediment.

Other conditions of soils may be of importance for agriculture but in the Basin these five are the main ones. The effects of temperature, light and wind vary little within the Basin.

9.2 Management systems and soil-improvement

As indicated at the beginning of the chapter, agricultural classifications of soils should consider what is possible in the local social, economic and technical circumstances; in other words, for any circumstances the management system determines the result.

Improvements depend on the removal of limitations, which is easier the less primitive the community.

In the Basin determinant social factors are the education of the farmers, the rural culture, agricultural traditions, the available land and the activity of the agricultural extension service.

Economic factors are: the financial resources of the farmer, farm size, type of land tenure, government policy, foreign aid, prices of produce and of fertilizers, wages and condition of the roads.

Within the scope of the Project we could hardly take these social and economic factors into account in considering the suitability of the soils. Therefore three management systems have been considered.

In *Management System A* the land is dry-farmed with a fallow every other year to restore productivity. Hardly any fertilizer is used. Technical skill is limited and what capital is available is not used for improvements. Machinery may be available through foreign aid but is rarely working because repair facilities are lacking. Crops, mainly cereals, are not weeded. This is well represented in the area and offers hardly any scope for improvement.

Fig. 78. Clayey Marl Soil (LmA). Suitability Class III under dry farming.

Şekil 78. Killi marn toprağı (LmA). Kuru ziraat altında Elverişlilik Sınıfı III.

In *Management System B* there is also alternate dry-farming and fallow. Fertilizer is applied superficially or by deep placement. Farmers are more skilled and machinery is widely used and kept in operational order. Capital is invested on maintenance, fertilizers, transport and weed control. Cereals are the main crop. It hardly exists in the Basin, but could be widely introduced and offers greatest improvement with limited water supplies.

In *Management System C* all the land is irrigated. Some is fallowed alternate years. The farmers are skilled and use capital, credit and fertilizers. Work is mechanized. Crops are mainly cereals and sugar-beet, with some melons, oilseeds and orchards (apples, pears, plums and apricots). It exists in irrigated areas but not in the advanced form suggested. Improvement is certainly possible.

The fertility trials (Chapter 7) have shown how unirrigated soils could become more productive under System B, which is the limit of development for most of the Basin. The amount of land which could be brought under irrigation is limited by the supply of surface or well water. Even under System C technical knowledge is still limited except in areas growing beet under contract for the sugar factory in Konya.

For System A the question is only whether cropping of a soil unit is possible or not. Under Systems B and C there may be an improvement in the soil condition: in other words limitations of the soil may be partly or completely removed, for instance with

Fig. 79. Clayey Marl Soil (LmA). Suitability Class II under irrigation.

Şekil 79. Killi marn toprağı (LmA). Sulama altında Elverişlilik Sınıfı II.

fertilizer, by altering the soil structure or by leaching out toxic salts. Often improvement may be a co-operative effort such as the irrigation projects initiated by Topraksu and DSİ. Scope for improvement is indicated in the Table for each Management System as three classes: *readily feasible*, *feasible* and *unfeasible*. *Perhaps feasible* is indicated where improvement would only be possible after thorough research and then only by large-scale reclamation beyond the scope of the farmer.

9.3 Soil capability

To conclude the information already gathered, a single scale of soil capability has been erected to indicate which of the three management systems could be used and how readily they could be introduced.

Soils of *Class I, good*, are suitable for cereals and other drought-resistant crops without improvement or after readily feasible and maintainable improvements for the dry-farming Systems A and B. With System C (irrigation) cultivation of a large variety of crops is possible and yields are high.

In *Class II, fair*, improvement may be more difficult although still feasible or the improvements may need more careful maintainance. Sometimes the limitations of the soil may be only partly removed, reducing crop choice in irrigated areas, yields or the use of machinery. Yields may be constantly or frequently lower than in Class I.

In *Class III*, *restricted*, several limitations cannot be completely removed so that choice of crop is restricted in irrigated areas and yields are constantly or frequently low.

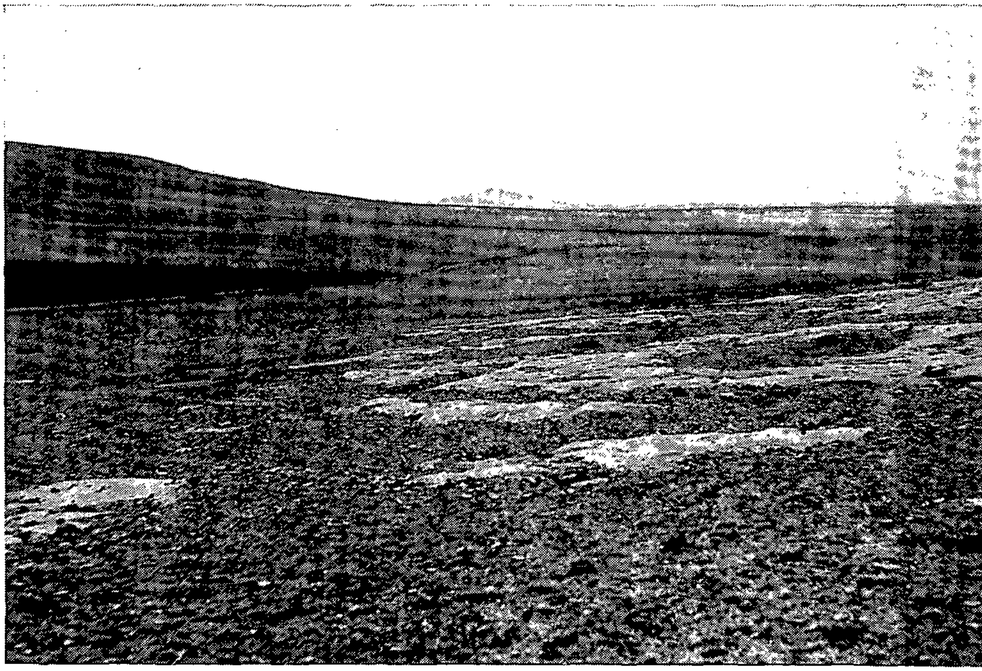
Soils of *Class IV* could not sustain arable farming. They are not economically used for cropping, except under very unusual management such as the use of salt-resistant crops. *Class IVa* may be used for ranging but *Class IVb* is not even suitable for grazing.

9.4 Conclusions and recommendations

From Table 25, the following general observations can be made.

Clays and loams are suitable for dry-farming (Systems A and B), unless the soils are saline, poorly drained or unsuitable for machinery (slope, erosion, stoniness). Except where there is seepage near the borders of the Basin, lack of water restricts them always to Class II, but usually even to Class III. In almost saltfree clays, marginal improvement of fertility and structure may be possible with deep-placed fertilizer,

Fig. 80. Undulating Terrace Soil (ThA). Unsuitable for irrigation. The foreground is Suitability Class IVa because of very shallow soil; the background with moderately deep soil is suitability Class III. Near Kızılkuyu, Karaman Area West.



Şekil 80. Ondüleli Teras Toprağı (ThA). Sulanmaya elverişli diğildir. Sığ toprak olması dolayısiyle ön plânda Elverişlilik Sınıfı IVa. Arka plânda orta derin toprak Elverişlilik Sınıfı III. Karaman bölgesi batısı Kızılkuyu yakınları.

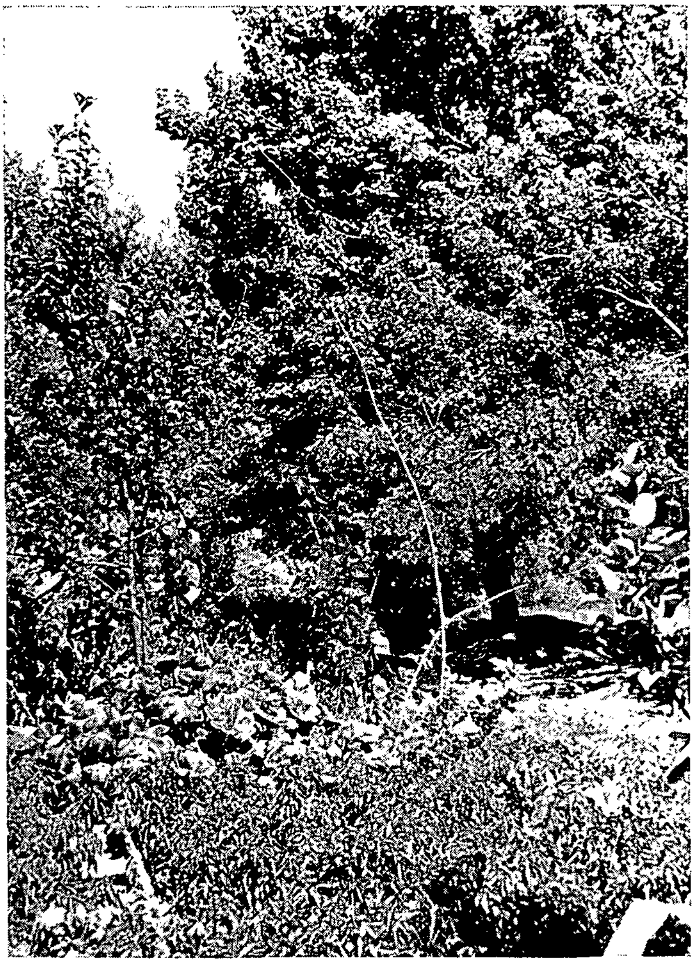


Fig. 81. Irrigated orchards and vegetable gardens on alluvial fan soil (May Fan near İçeriçumra, AmA). Suitability Class I. If dry-farmed the land would be Class III.

Şekil 81. Alluviyal yelpaze toprağında sulanan meyve ağaçları ve sebze bahçeleri (May çayı yelpazesi, İçeri Çumra yakınları, AmA). Elverişlilik Sınıfı I. Eğer kuru ziraat tatbik edilirse Elverişlilik Sınıfı III olacaktır.

organic manure and careful moisture conservation.

In many sandy and carbonatic soils improvement, especially of moisture status, is even more difficult. Such slight improvements, possible under system B, are indicated with a +.

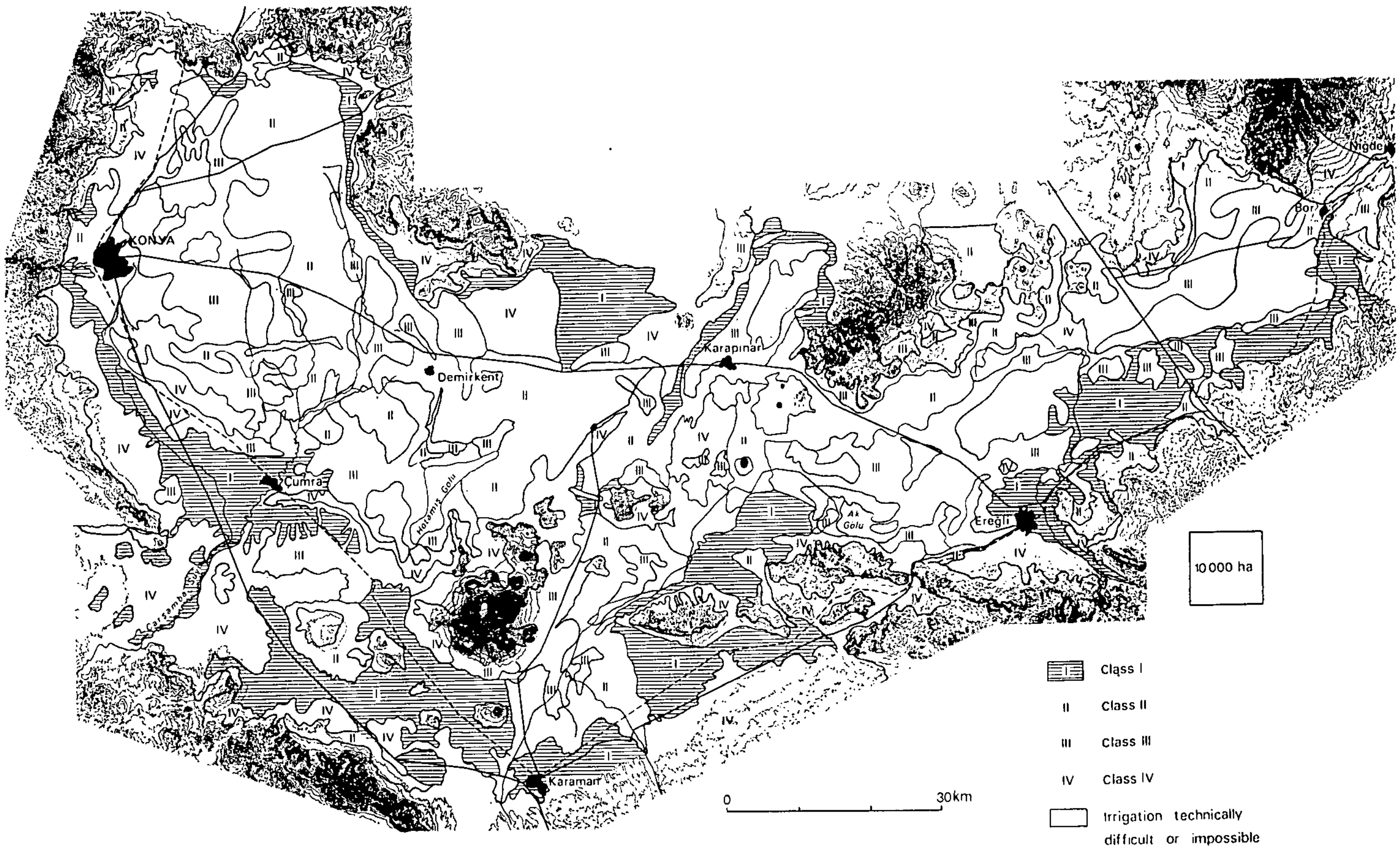
Very heavy vertic clays can be improved with heavy machinery and skilled management under System B.

Moderately salt-affected clays and sands (mainly internal solonchaks) are restricted or unsuitable for System A but can be used under System B if the drainage is improved.

Soils with hardly any limitations are under System C generally in Class I. Where such soils are, as occasionally, Class II, this must be due to unfavourable topography, field shape or salinity.

With irrigation, reclamation of moderately or strongly salt-affected soil or the steep slopes is considered perhaps feasible. The economic justification of reclaiming steeper

Fig. 82. Soil suitability of the Basin under Management System C (explanation in the text).



Şekil 82. Havzada amenajman sistemi altında Toprak Elverişliliği (izahı yazıda).

slopes and poorly drained saline areas of the Basin is doubtful so that the capability of the soils under System C is indicated by IVa.

If only part of the mapping unit is salt-affected, which is indicated on the soil map but not the legend (except for units LmD and LmE), the Table indicates the capability of the saltfree or slightly affected part. The moderately or strongly affected part is considered to belong *always* to Class IVa under Management System A and B and under Management System C to III if moderately affected or to IVa if strongly affected.

Sandy soils under System C without severe agricultural restriction are not classed higher than II or III, because their rapid permeability wastes irrigation water which could better be used elsewhere. Use of fertilizer on irrigated sandy soils may be equally wasteful through leaching unless well manured with organic material and used for horticultural crops with a sophisticated irrigation system. They then reach Class I.

In the framing of a sound agricultural policy it is no use introducing or recommending another management system unless the capability of the soil is raised at least one class. Areas can thus be selected for development. Sandy soils should not be irrigated unless for market gardening.

The soil suitability classification is illustrated with photos in Figs. 78, 79, 80 and 81 and by a map in Fig. 82. The map shows the suitability of the Basin if it were entirely under the circumstances of Management System C. Areas where irrigation would be technically very difficult as on steep slopes, dissected terrain or sanddunes are left blank. A suitable drainage system is supposed to avoid flooding.

The map indicates, that in general only the higher border areas such as the Bajadas, the Terraces and the upper parts of the Alluvial Fans should be considered for improvement into System C.

Where surface irrigation is impossible, the most promising system seems to be improved dry farming (System B) perhaps with irrigation from wells in May where possible (transition to System C!).

9.5 Short explanation of Table 25

Table 25 is a review which shows for each mapping unit:

1. The data of 9 characteristics pertinent to land-use.
2. The agricultural status of the soil in terms of its deviations from optimum status (no limitation or slight, moderate, or severe limitations).
3. The feasibility of removing the above limitations in three different management systems

readily feasible (++)
feasible (+)
unfeasible (—)
perhaps feasible (±)

If there are no limitations, improvement is not necessary (○). A (×) indicates that the soil unit is unsuitable for the particular management system.

The management systems distinguished are:

A. Dry farming, no fertilizers, little capital or skill.

B. Dry farming with fertilizers, more capital and skill.

C. Irrigated farming with fertilizers, sufficient capital and skill.

From the information in Table 25 a capability classification is derived for each mapping unit under the management systems A, B and C.

The capability classes are summarized as follows:

Class I *Good*: suitable for cereals under systems A and B and for a large variety of crops under System C. Improvements easy and lasting.

Class II *Fair*: moderately suitable for cereals under A and B and for a limited variety under C. Improvements are difficult but feasible.

Class III *Restricted*: very poor results for cereals under A and B and limited choice under C. Limitations are severe and cannot be removed or only with great effort, much depending on the management class (capital and skill).

Class IV *Not suitable for arable farming*

IVa Ranging possible

IVb Ranging not possible (Badlands).

The data on the table are for saltfree soils (except for units LmD and LmE), but the moderately or strongly affected soils (see soil map) are always Class IV under the management systems A and B and Class III (if moderately affected) or Class IV (if strongly affected) under system C.

It is recommended not to introduce a more elaborate management system unless the capability of the soil unit is raised at least one class.

9.5 Tablo 25'in kısa izahı

Tablo 25 her harita ünitesinin tekrar gözden geçirilmesini göstermektedir

1. Toprak kullanılmasiyle çok yakın bağlaşan seçilmiş 8 özelliğe ait kayıtlar
2. Optimal durumdan sapmalar olarak toprağın tarımsal durumu (hafif veya yok, orta veya çok engeller).
3. Üç değişik amenajman sistemi için, yukarıda zikredilen engellerin geliştirilmesi imkânı

   Misal. halihazırda mümkün (++)
   Mümkün (+)
   Mümkün değil (—)
   Belki mümkün (±).

Engellerin olmaması halinde geliştirmeye lüzum yoktur.

(o) . Bir (×) bahis mevzuu toprak ünitesinin amenajman sistemine uygun olmadığını işaret etmektedir, meselâ tepelik arazilerin sulanması.

Tesbit edilen amenajman sistemleri şunlardır:

A. Sermaye ve ustalıkla, sun'i gübresiz kuru ziraat
B. Daha fazla sermaye ve ustalıkla sun'i gübreli kuru ziraat
C. Yeterli sermaye ve ustalıkla, sun'i gübreli sulu ziraat.

A, B, C. amenajman sistemleri altında tablo 25'deki danışma dayanılarak her haritalama ünitesi için toprak kabiliyet sınıflandırması yapılmıştır.

Kabiliyet sınıfları aşağıdaki gibi özetlenir:

Sınıf I İyi: A ve B sistemi altında hububatlara ve C sistemi altında geniş bitki türlerine elverişli. Geliştirme kolay ve devamlıdır

Sınıf II *Oldukça iyi:* A ve B altında hububatlara orta, C altında sınırlı türlere elverişli. Geliştirme zor fakat mümkündür.

Sınıf III *Sınırlı:* A ve B altında hububat için çok zayıf ve C altında seçim sınırlı. Engeller çoktur ve giderilemez veya daha çok amenajman sınıfına bağlı olarak yalnız büyük gayretle giderilebilir (sermaye ve ustalıkla).

Sınıf IV *Tarla ziraatı için uygun değil*
VI A Değişmesi mümkündür
VI b Değişmesi mümkün değildir (verimsiz araziler)

Tablodaki kayıtlar tuzsuz topraklar içindir (LmD ve LmE üniteleri hariç), fakat orta veya çokça tuz etkisinde kalmış topraklar (toprak haritasına bakınız) A ve B amenajman sistemi altında daima sınıf IV içersine, C sistemi altında sınıf III (eğer orta derecede tuzlanmışsa) veya sınıf IV içersine girmektedirler.

Toprak ünitesinin kabiliyet sınıfı en azından bir derece yükseltilemediği sürece, daha geliştirilmiş amenajman sisteminin takdim edilmemesi tavsiye edilir.

Table 25

		Mapping units				
		CrA	CvA	TeA	TeB	TeC
Data pertinent to soil use						
Total area (ha)/%		73,680/6.36	8,160/0.70	13,600/1.17	29,600/2.56	32,560/2.8
Effective soil depth		shallow- mod. deep	mod. deep- deep	mod. deep	mod. deep	shallow- mod. de
Texture surface soil		gravelly loamy	gravelly ash	clayey	loamy	loamy or clayey
Drainage class		mod. well	excessive	mod. well	mod. well	mod. well
inundations		no	no	no	no	no
Predominant salinity degree (see soil map)		saltfree	saltfree	slightly aff.	slightly aff.	slightly aff
Slope class (single or complex)		mod. steep	mod. steep	level	level	undulating
Permeability surface soil		mod.	rapid	mod.	rapid	rapid
permeability subsoil		mod.	rapid	slow	mod.	slow
Other		erosion class 2	erosion class 2			
Agricultural status of the soil, its degree of deviation and the feasibility for improvement per management syster						
Natural fertility limitation		mod.	mod.	slight	slight	mod.
improvement of management system	A	–	–	–	–	–
	B	+	+	+	+	+
	C	×	×	++	++	++
Soil structure limitations		no	no	slight	no	mod.
improvement of management system	A	○	○	–	○	–
	B	○	○	+	○	+
	C	×	×	++	○	+
Water limitation		mod.	mod.	strong	strong	strong
improvement of management system	A	–	–	–	–	–
	B	–	–	+	–	–
	C	×	×	++	++	(+)
Oxygen limitations		no	no	no	no	locally mod
improvement of management system	A	○	○	○	○	–
	B	○	○	○	○	–
	C	×	×	○	○	–
Use of agric. implements lim.		mod.	mod.	no	no	mod.
improvement of management system	A	–	–	○	○	–
	B	+	+	○	○	+
	C	×	×	○	○	+
Soil suitability						
for management system	A	III-IVa	III-IVa	II	II	III
	B	III	II	II+	II+	III+
	C	×	×	I	I	III

Continued on following pages.

	ThA	ThB	TcA	TcB	TcC	TgA
/064	111,600/8.50	45,160/5.05	39,000/3.38	13,640/1.18	5,520/0.48	5,640/0.49
ow-	shallow	very shallow	very shallow	shallow	very shallow	shallow
d. deep						
nic	cobbly	cobbly	loamy	loamy	loamy	loamy
m	clayey	clayey				
well	well	well	poorly	very poorly	very poorly	mod. well
	no	no	occasional	annual	annual	frequent
tly aff.	saltfree	saltfree	mod. aff.	strongly aff.	strongly aff.	saltfree
	rolling	rolling	level	level	level	gently sloping
l	mod.	mod.	mod.	slow	very slow	mod.
	very slow	very slow	very slow	very slow	very slow	mod.
	erosion class 2–3	erosion class 3–4				
.	mod.	strong	strong	strong	strong	mod.
	—	—	—	—	—	—
	+	—	—	—	—	+
	+	—	+	—	—	+
l.	mod.	mod.	strong	strong	strong	strong
	—	—	—	—	—	—
	+	—	+	—	—	+
	+	—	+	—	—	+
ng	strong	strong	mod.	slight	slight	mod.
	—	—	—	—	—	—
	—	—	—	—	—	—
	(+)	—	+	+	—	+
	no	no	mod.	strong	strong	no
	○	○	—	—	—	○
	○	○	—	+	—	○
	○	○	+	+	—	○
	strong	strong	no	strong	strong	mod.
	—	—	○	—	—	+
	+	—	○	—	—	+
	+	—	○	—	—	+
	III loc. IVa	IVa	III-IVa	IVa	IVa	III
	III loc. IVa	IVa	III-IVa	IVa	IVa	III^{+}
	×	×	III	×	×	III^{+}

Table 25. Continued

		Mapping units				
		BrA	BrB	BrC	BrD	BvA
Data pertinent to soil use						
Total area (ha)/%		65,940/5.70	40,600/3.51	28,040/2.42	15,460/1.34	13,360/1.1
Effective soil depth		very deep	very deep	mod. deep	deep	mod. deep
Texture surface soil		clayey	clayey or loamy	gravelly loamy	gravelly loamy	heavy clay
Drainage class		well	well	well	well	poorly
inundations		no	no	no	no	frequent
Predominant salinity degree (see soil map)		saltfree-slightly aff.	saltfree-slightly aff.	saltfree	slightly aff.	mod. aff.
Slope class (single or complex)		gently sloping	gently sloping	sloping	sloping	level
Permeability surface soil		rapid	rapid	rapid	rapid	slow
permeability subsoil		mod.-slow	rapid	rapid	rapid	slow
Other						
Agricultural status of the soil, its degree of deviation and the feasibility for improvement per management system						
Natural fertility limitation		slight	slight	mod.	mod.	slight
improvement of management system	A	–	–	–	–	–
	B	++	++	+	+	+
	C	++	++	+	+	++
Soil structure limitations		slight	slight	slight	mod.	strong
improvement of management system	A	–	–	–	–	–
	B	++	++	+	±	–
	C	++	++	+	±	–
Water limitation		mod.-strong	mod.-strong	strong-mod.	mod.	mod.
improvement of management system	A	–	–	–	–	–
	B	±	±	±	±	±
	C	++	++	+	+	++
Oxygen limitations		no	no	no	no	mod.
improvement of management system	A	O	O	O	O	+
	B	O	O	O	O	+
	C	O	O	O	O	+
Use of agric. implements lim.		no	no	slight	mod.	mod.
improvement of management system	A	O	O	–	–	–
	B	O	O	+	±	+
	C	O	O	+	±	+
Soil suitability						
for management system	A	II	II	III	III	II
	B	II+	II+	II	II	II+
	C	I	I	II	II+	II+

Continued on following pages

	BvC	AaA	AaB	AbA	AbB	AbC	AbD
)/1.95	26,760/2.31	6,720/0.58	3,680/0.32	23,220/2.01	Similar to AbA	14,000/1.21	2,440/0.21
w- d. deep	mod. deep	deep	deep	deep		shallow- mod. deep	mod. deep- deep
lly my	gravelly loamy/ sandy	carbonatic clay	carbonatic loam	heavy clay		clayey	clayey
	well	mod. well	well	poorly		poorly	very poorly
	no	occasional	occasional	frequent		frequent	annual
ee	saltfree	slightly aff.	saltfree	mod. aff.		mod. aff.	strongly
ng	mod. steep	level	nearly level	level		level	level
	rapid	mod.	rapid	rapid (dry)		slow	slow
ly slow	rapid	mod.	slow	slow (wet)		slow	slow
pans	erosion class 2			very slow			
.	strong	mod.	mod.	mod.		mod.	strong
	–	–	–	–		–	–
	+	+	+	+		+	–
	+	++	++	+		+	+
t	slight	mod.	mod.	strong		mod.	strong
	○	–	–	–		–	–
	○	+	+	–		+	–
	○	+	+	+		+	+
.	mod.	strong	strong	strong		strong	mod.
	–	–	–	–		–	–
	–	–	–	–		–	–
	+	++	++	++		+	+
	no	no-slight	no	mod.		mod.	strong
	○	○	○	+		+	–
	○	○	○	+		+	–
	○	○	○	+		+	+
d.	mod.	no	no	mod.-strong		no	mod.
	–	○	○	–		○	–
	+	○	○	+		○	+
	+	○	○	+		○	+
	III	III	III	III-IVa	III	III	III-IVa
	III^+	II	III^+	III	III^+	III^+	III^+
	III^+	II	I	II	II	II	II

Table 25. Continued.

		Mapping units				
		AbE	AcA	AcB	AcC	AdA
Data pertinent to soil use						
Total area (ha)/%		1,320/0.11	9,480/0.82	9,180/0.79	2,520/0.22	2,600/0.22
Effective soil depth		very deep	deep	deep	deep	very deep
Texture surface soil		clayey or loamy	clayey	loamy	loamy-sandy	clayey
Drainage class		well	mod. well	well	well	well
inundations		no	no	no	no	no
Predominant salinity degree (see soil map)		mod. aff.	mod. aff.	slightly aff.	saltfree	slightly aff
Slope class (single or complex)		nearly level	level	level	level	level
Permeability surface soil		mod.-rapid	mod.	rapid	rapid	mod.
permeability subsoil		mod.	slow	mod.	rapid	mod.
Other		erosion class 2				
Agricultural status of the soil, its degree of deviation and the feasibility for improvement per management syste						
Natural fertility limitation		mod.	mod.	mod.	mod.	mod.
improvement	A	–	–	–	–	–
of management	B	+	+	+	+	+
system	C	+	++	++	+	++
Soil structure limitations		no	slight	no	mod.	no
improvement	A	O	O	O	–	O
of management	B	O	O	O	+	O
system	C	O	O	O	+	O
Water limitations		strong	strong	mod.	strong	strong
improvement	A	–	–	–	–	–
of management	B	–	+	+	–	+
system	C	+	++	++	+	++
Oxygen limitations		no	no	no	no	no
improvement	A	O	O	O	O	O
of management	B	O	O	O	O	O
system	C	O	O	O	O	O
Use of agric. implements lim.		no	no	no	no	no
improvement	A	O	O	O	O	O
of management	B	O	O	O	O	O
system	C	O	O	O	O	O
Soil suitability						
for management system	A	II	II	II	III	III
	B	II+	II+	II	III+	II
	C	II	I	I	II	I

Continued on following pages.

	AeA	AeB	AfA	AfB	AgA	AgB
/0.09	6,440/0.56	800/0.07	14,520/1.25	1,760/0.15	4,120/0.36	3,040/0.26
	mod. deep	deep	very deep	very deep	deep	deep
y	clayey	loamy	clayey	loamy	clayey	loamy or sandy
	imperfect	well	well	well	well	well
	no	no	no	no	no	no
ee	mod. aff.	saltfree	saltfree	saltfree	slightly aff.	saltfree
y el	level	level	nearly level	nearly level	nearly level	nearly level
	mod.	mod.	rapid	rapid	mod.	mod.
	slow	mod.	mod.	rapid	rapid	rapid
	strong	mod.	mod.	mod.	slight	mod.
	—	—	—	—	—	—
	+	+	+	+	+	+
	+	++	++	++	++	++
	slight	slight	no	no	no	no
	○	○	○	○	○	○
	○	○	○	○	○	○
	○	○	○	○	○	○
g	mod.	strong	mod.	strong	mod.	mod.
	—	—	—	—	—	—
	+	—	+	—	+	—
	+	++	++	+	++	++
	no or slight	no	no	no	no	no
	○	○	○	○	○	○
	○	○	○	○	○	○
	○	○	○	○	○	○
	no	no	no-slight	no-slight	no	no
	○	○	○	○	○	○
	○	○	○	○	○	○
	○	○	○	○	○	○
	III	III	II	III	II	III
	II	III^+	II^+	II	II^+	II
	II^+	II	I	I	I	I

Table 25. Continued.

		Mapping units				
		AgC	AhA	AhB	AkA	AkB
Data pertinent to soil use						
Total area (ha)/%		4,520/0.39	6,760/0.58	1,080/0.09	13,400/1.02	2,800/0.24
Effective soil depth		shallow	mod. deep	deep	deep	very deep
Texture surface soil		clayey	clayey	loamy	clayey	loamy
Drainage class		poorly	mod. well-imperfectly	well	mod. well	well
inundations		frequent	no	no	slight	no
Predominant salinity degree (see soilmap)		mod. aff.	slightly-mod. aff.	saltfree	saltfree-slightly aff.	saltfree
Slope class (single or complex)		level	nearly level	nearly level	nearly level	nearly leve
Permeability surface soil		slow	mod.	mod.	mod.	rapid
permeability subsoil		slow	slow	mod.	mod.	rapid
Other		complex unit	complex unit	complex	complex	
Agricultural status of the soil, its degree of deviation and the feasibility for improvement per management system						
Natural fertility limitation		strong	mod.	slight	mod.	slight
improvement of management system	A	—	—	—	—	—
	B	—	+	+	+	—
	C	+	+	++	++	++
Soil structure limitations		strong	mod.	no	slight	no
improvement of management system	A	—	—	O	O	O
	B	—	+	O	O	O
	C	+	+	O	O	O
Water limitations		no	strong	mod.	strong-mod.	strong
improvement of management system	A	O	—	—	—	—
	B	O	+	+	+	—
	C	O	++	++	++	++
Oxygen limitations		strong	no-slight	no	slight	no
improvement of management system	A	—	O	O	O	O
	B	—	O	O	O	O
	C	+	O	O	O	O
Use of agric. implements lim.		no	no	no	no	no
improvement of management system	A	O	O	O	O	O
	B	O	O	O	O	O
	C	O	O	O	O	O
Soil suitability						
for management system	A	IV[a]	III-IV[a]	III	III	III
	B	IV[a]	III	III+	III+	III+
	C	III	II	II	II	I

Continued on following pages.

	AmB	AmC	AnA	AsA	AsB	AuA
0.66	1,000/0.09	2,840/0.25	19,960/1.72	20,200/1.74	1,200/0.10	19,960/1.72
eep	shallow	deep	mod. deep	deep	mod. deep	mod. deep
am	silt loam	fine sandy	clayey and loamy	clayey	sandy	gravelly clay
	well	well	mod. well	mod. well	well	well
	no	no	no	no	no	no
ly	slightly	saltfree	saltfree-slightly aff.	slightly aff.	saltfree	saltfree
	level	level	nearly level	nearly level	nearly level	sloping
	rapid	rapid	mod.	mod.	rapid	mod.
	mod.	rapid	mod.	mod.	rapid	mod.
						erosion class 2–3
	mod.	strong	mod.	mod.	strong	mod.
	—	—	—	—	—	—
	+	—	—	—	—	—
	++	+	++	++	+	+
	no	mod.	no	no	mod.	mod.
	○	—	○	○	—	—
	○	+	○	○	+	—
	○	+	○	○	+	+
g	strong	strong	strong	strong	strong	mod.
	—	—	—	—	—	—
	—	—	—	—	—	—
+	++	+	++	++	+	+
	no	no	no	no	no	no
	○	○	○	○	○	○
	○	○	○	○	○	○
	○	○	○	○	○	○
	no	no	no	no	no	mod.-strong
	○	○	○	○	○	—
	○	○	○	○	○	+
	○	○	○	○	○	+
	III	IV[a]	III	III	IV[a]	IV[a]
	III$^+$	III	III$^+$	II	III	III
	I	II	II	I	II	×

Table 25. Continued.

	Mapping units				
	AuB	AuC	LmA	LmB	LmC
Data pertinent to soil use					
Total area (ha)/%	16,200/1.40	18,980/1	144,880/2.52	20,760/1.79	35.440/3.0
Effective soil depth	shallow	mod. deep	mod. deep	deep	mod. deep
Texture surface soil	sand + gravel	gravel + ash	carbonatic clay	carbonatic loam	carbonatic clay
Drainage class	excessive	excessive	mod. well	well	mod.
inundations	no	no	occasional	no	occasional
Predominant salinity degree (see soilmap)	saltfree	saltfree	slightly aff.	saltfree	slightly aff.
Slope class (single or complex)	sloping	sloping	level	nearly level	level
Permeability surface soil	rapid	rapid	mod.	mod.	mod.
permeability subsoil	rapid	rapid	slow	mod.	slow
Other	erosion class 2–3	erosion class 2			
Agricultural status of the soil, its degree of deviation and the feasibility for improvement per management system					
Natural fertility limitation	strong	strong	mod.	mod.	mod.
improvement of management system A	–	–	–	–	–
B	–	+	+	+	+
C	+	+	+	+	++
Soil structure limitations	strong	no	slight	no	no
improvement of management system A	–	O	O	O	O
B	–	O	O	O	O
C	–	O	O	O	O
Water limitations	strong	mod.	strong	mod.	strong
improvement of management system A	–	–	–	–	–
B	–	–	+	+	+
C	+	+	++	++	++
Oxygen limitations	no	no	no	no	no
improvement of management system A	O	O	O	O	O
B	O	O	O	O	O
C	O	O	O	O	O
Use of agric. implements lim.	strong	mod.	no	no	no
improvement of management system A	–	–	O	O	O
B	–	+	O	O	O
C	–	+	O	O	O
Soil suitability					
for management system A	IV[b]	IV[a]	III-IV[a]	III	III
B	IV[b]	III	III	III+	II
C	×	×	II	II	II

Continued on following pages.

	LmE	LmF	LrA	LrB	LpA	LpB
)/1.91	14,120/1.22	5,600/0.48	12,520/1.08	3,320/0.29	2,960/0.26	7,200/0.62
w	very shallow	shallow	deep	deep	shallow	mod. deep
natic	carbonatic	carbonatic	carbonatic	carbonatic	sandy	sandy
y	clay	clay	sand	loamy sandy		
y	very poorly	poorly	excessive	well	well	excessive
ent	annual	frequent	no	no	no	no
aff.	strongly aff.	mod. aff.	saltfree	saltfree	mod. aff.	saltfree
	level	level	high ridge	low ridge	level	nearly level
	slow	mod.	very rapid	rapid	rapid	rapid
	very slow	mod.	very rapid	rapid	mod.	rapid
						topography hummocky
g	strong	strong	strong	strong	strong	strong
	—	—	—	—	—	—
	—	—	—	—	—	—
	+	+	+	+	+	+
g	strong	strong	mod.	mod.	strong	no
	—	—	—	—	—	○
	—	+	+	+	+	○
	—	+	+	+	+	○
g	mod.	mod.	strong	strong	strong	strong
	—	—	—	—	—	—
	—	—	—	—	—	—
	+	+	+	+	+	+
.	strong	mod.	no	no	no	no
	—	—	○	○	○	○
	—	+	○	○	○	○
	+	+	○	○	○	○
	mod.	no	no	no	no	strong
	—	○	○	○	○	—
	—	○	○	○	○	—
	+	○	○	○	○	+
	IV^{b}	IV^{a}	IV^{a} – III	IV^{a} – III	IV^{a}	IV^{a}
	IV^{b}	IV^{a}	IV^{a} – III	IV^{a} – III	IV^{a}	IV^{a}
	×	III	III	III	III	III

Table 25. Continued.

		Mapping units				
		Lpc	LpD	LoA	LoB	MfA
Data pertinent to soil use						
Total area (ha)/%		7,200/0.62	9.010/0.78	7,040/0.61	5,680/0.49	8,400/0.73
Effective soil depth		mod. deep	mod. deep	very deep	shallow-mod. deep	very shallo
Texture surface soil		sand + ash	loamy or sandy	sandy	sandy	carbonatic clayey
Drainage class		excessive	imperfect	excessive	excessive	very poorl
inundations		no	frequent	no	no	annual
Predominant salinity degree (see soilmap)		saltfree	mod. aff.	saltfree	saltfree	strongly af
Slope class (single or complex)		nearly level	nearly level	undulating	gently sloping	level
Permeability surface soil		rapid	mod.	rapid	rapid	slow
permeability subsoil		rapid	slow	rapid	slow	slow
Other			very complex unit		hummocky topography	marsh
Agricultural status of the soil, its degree of deviation and the feasibility for improvement per management syste						
Natural fertility limitation		mod.	mod.	strong	strong	strong
improvement of management system	A	–	–	–	–	–
	B	+	–	–	–	–
	C	+	+	+	+	+
Soil structure limitations		no	mod.	no	no	mod.
improvement of management system	A	O	–	O	O	–
	B	O	–	O	O	–
	C	O	+	O	O	+
Water limitations		mod.	mod.	strong	strong	mod.
improvement of management system	A	–	–	–	–	–
	B	–	–	–	–	–
	C	+	+	+	+	+
Oxygen limitations		no	mod.	no	no	strong
improvement of management system	A	O	–	O	O	–
	B	O	+	O	O	–
	C	O	+	O	O	+
Use of agric. implements lim.		no	no	mod.	mod.	strong
improvement of management system	A	O	O	–	–	–
	B	O	O	+	+	–
	C	O	O	+	+	+
Soil suitability						
for management system	A	III	III	$IV^a + IV^b$	IV^a	IV^b
	B	III^+	III^+	$IV^a + IV^b$	IV^a	IV^b
	C	II	II + III	×	×	×

Tablo 25. Toprak kayıtlarının yeniden gözden geçirilmesi ve üç değişik amenajman sistmi altında bütün ha ünitelerinin toprak elverişliliği ve tarımsal toprak durumlarını sınırlıyan hususlar. Açıklama için yazıya bakı

	MfB	MfC	MfD	DdA	DdB
/0.59	6,960/0.60	5,320/0.46		4,320/0.37	4,760/0.41
w	shallow	mod. deep	very shallow	very deep	very deep-shallow
natic	clayey	loamy	loamy	sandy	sandy
yey					
well	poorly mod.-well	poorly	mod. well	excessive	excessive
ently	annual	annual	occasional	no	no
aff.	strongly aff.	mod. aff.	strongly aff.	saltfree	saltfree
	level	level	level	sloping	sloping
	slow	mod.	mod.	rapid	rapid
	slow	mod.	slow	rapid	rapid-slow
	complex unit	complex unit		dunes	dunes
g	strong	mod.	strong	strong	strong
	—	—	—	—	—
	—	—	—	—	—
	+	+	—	+	+
.	mod.	no	strong	no	no
	—	○	—	○	○
	—	○	—	○	○
	+	○	—	○	○
.	mod.	mod.	strong	strong	strong
	—	—	—	—	—
	—	—	—	—	—
	+	+	+	+	+
l.	mod.	mod.	mod.	no	no
	—	—	—	○	○
	+	—	+	○	○
	+	+	+	○	○
	mod.	strong	no	strong	strong
	—	—	○	—	—
	+	—	○	+	+
	+	+	○	+	+
	IV[a]	IV[a]	IV[a]	IV[b]	IV[a]
	IV[a]	IV[a]	IV[a]	IV[b]	IV[a]
	III + IV[b]	III	×	×	×

10 Soil survey and research

10.1 General outline

Any reconnaissance survey should work to the following scheme (Buringh, 1960, 1961):

1. Scrutiny of available aerial photographs, topographic and geologic maps, existing reports and other literature about the area.
2. Brief orientative field trip.
3. Systematic analysis of all aerial photographs by stereoscopic study to prepare a preliminary photo-interpretation map with legend. (Fig. 83).

If Stage 2 is not possible, Stage 3 may follow 1. After Stage 3 sample areas or sample strips (De Meester, 1961) should be selected for detailed survey. The operation can be planned. The headquarters, field stations, routes, assignments of surveyors and labourers and materials can be selected.

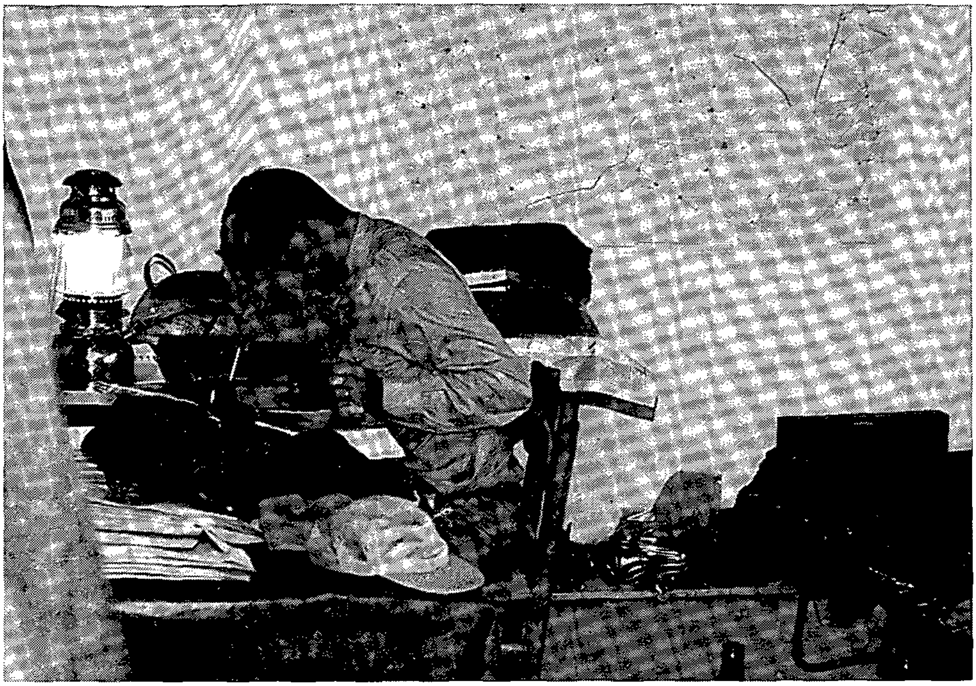
4. Survey teams survey sample areas in detail and correlate them with the aerial photographs. Profiles are observed in soil pits and by augering at selected sites. They describe profiles and sample soils only in the chosen sample areas.
5. The correlator compiles the reconnaissance soil legend from the results gathered and he defines each mapping unit as far as possible.
6. Field check and revision of the photo-interpretation map between the sample area from the reconnaissance soil legend. The interpretation map can thus be translated into a soil map. Checks are in a few representative sites outside the sampled areas, not in a grid system.
7. The correlator compiles the final reconnaissance soil map and legend.
8. All necessary information and soil data are compiled into the soil survey report as described in the Soil Survey Manual (1951, p. 409–434).

The field check between the sample areas (stage 6) may be fairly detailed for 'detailed reconnaissance surveys' (scale about 1 : 100,000) or cursory for an 'exploratory' soil map (scale 1 : 500,000), in which case the interpretation map is translated into a soil map merely by interpolation between sample areas.

The amount of checking and interpolation depends much on the skill of the correlator and the interpreter and also on the interpretability of the area.

The Konya Project has completed all stages but not always in the most efficient order because the Project was intended primarily for training students and for research. The students mostly worked fairly independently on detailed sample areas, made a preliminary photo-interpretation map and tentatively field-checked surround-

Fig. 83. Stereoscopic study of aerial photographs in the field station during a soil survey (Karapınar Camp).



Şekil 83. Toprak etüd ve haritalama sırasında tarla istasyonunda (Karapınar Kampı) stereoskopik hava fotoğrafı çalışması.

ing areas. They were not closely supervised. The large number of participants, at least 33 in groups usually of 5 or 6, made continuity difficult. The final field check and general correlation has been mainly in the hands of the author, who also thoroughly revised the photo-interpretation.

10.2 Interpretation of aerial photographs

The Turkish Topographic Service kindly provided aerial photographs of the whole area. Most prints were sharp and had good contrast. But scales between various blocks of runs varied considerably and many prints looked tilted. The age of the photographs, which were taken about 1955, caused confusion because of many changes in roads, canals and land-use since. The entire area was photographed again in 1967 by the Turkish Army Mapping Service. Enlargements of single prints were available but those were of little use in reconnaissance mapping. Photomosaics of the Basin were not available except one for the Çumra area, which the Turkish Topographic Service especially made for the Konya project; it was not available for reproduction as a foundation for the soil map. The success of stereoscopic analysis of aerial photographs depended on correlation between visible boundaries and soil boundaries. This value was different in the various physiographic units of the Basin.

In the Uplands, Colluvial Slopes, Terraces and Bajadas, relief, slope erosion-pattern and land-use indicated reliable boundaries between the associations (except between Terrace and Bajada) and marked off phases such as shallow, eroded, gravelly or angular-cobbly, but they needed confirmation by fieldwork.

The Alluvial Fans were marked by intensive cultivation. Land-use indicated boundaries with adjacent soil associations and distinguished phases such as 'low' and 'saline'. Orchards and market gardens, near a village indicated coarse textured soils. The size and shape of fields in old cultivated land (small and irregular) and in land newly brought into cultivation (big, and regular) distinguished soils different in texture and drainage (Fig. 84). The irrigation and drainage patterns in the Alluvial Fans, in particular the Çarşamba Fan, often distinguished medium-textured (levee) soils (AcB) and very fine textured (basin) soils (AbA and AbB). The medium-sized fans are characterized mainly by their conical shape and radiating stream channels.

The boundaries of units in the Lacustrine Plain were all readily visible on aerial photographs, mainly by differences in natural vegetation, land-use and photographic tone. The Sandridges and Sand Dunes of course, stood out clearly by relief and shape.

Land-use was a tricky element in the Lacustrine Plain. Many uncultivated areas were salt-affected but others were non-saline marl used for communal grazing. Saline

1 new fields 2 old fields 3 rangeland

Fig. 84. The size and shape of fields in old (a) and newly cultivated land (b) Near Akçaşehir (Karapınar Area).

Şekil 84. Tarlaların şekil ve büyüklüğü (a) eski (b) yeni kültüre alınmış araziler. Akşehir yakınları (Karapınar bölgesi).

areas around irrigation canals looked mottled. The Marl Soil with organic surface soil (LmC) showed up darker.

Soft Lime Soils (Tc) and Marshes are almost all covered with tufted reed (*Juncus*) which forms a characteristic photographic pattern. The limits must be traced in the field. Another tricky element in all landscapes was *Peganum harmala* which grew densely in irregular patterns in well drained areas around villages, yaylas and wells and in volcanic deposits. Its boundaries stood out clearly on the photographs but seemed to indicate no more than a high nitrate content. It is not eaten by sheep or cattle.

Sandplains (Lp) are not cultivated and are often characteristically hummocky. Some easily detectable relief and other features were significant as soil features such as dunes, escarpments, cliffs, dolines, gullies, pools, creeks and springs. They could be mapped by photo-interpretation alone.

The examples have been of correlations between single photographic features and soil differences. Others based on combinations of elements could be used as our knowledge of the Basin increased. Of course no meaning could be attached to the boundaries until soil characteristics had been examined in the field.

10.3 Fieldwork

Small sampling teams of one or two participants and two or three labourers each had a Landrover. Routine soil cores were taken by Edelman-type auger to a depth of 120 or 200 cm, preferably at selected spots, or if necessary (mostly in sample areas) at regular intervals along roads or traverses, but always in relation to the photo-interpretation map. Teams immediately pinpointed sites on an aerial photograph or a topographic map. They determined and recorded the main soil properties such as colour (Munsell notation), texture (United States Soil Surveys terminology), porosity and mottling while on the spot. Specific features such as concretions, shells, relief, slope and land-use were noted.

After the first reconnaissance, sites were selected for soil pits to be dug. The pits were 150–200 cm deep with a flat wall facing away from the sun, and steps for acces.

Each horizon of really representative profiles was sampled, as a mixed sample for chemical analysis. Soil peels of whole profiles (soil monoliths) were prepared for morphological analysis in the laboratory (Fig. 85); See de Meester (Part B).

Characteristic or peculiar horizons were sampled without disturbance with steel rings or by isolating single elements, which were coated with Saran Resin to prevent damage (Brasher, 1966). Such samples can be used for determining bulk density and pF curves, for making thin-sections or both.

Samples for salinity studies and moisture content were taken by auger at intervals of 10 or 20 cm down the profile and sealed in double plastic bags. The entire Project involved about 20,000 augering cores and 600 soil pits. About 60 soil peels of 30 × 170 cm have been preserved.

The fieldwork for the special studies has been very varied. For genesis studies, structure, biological activity, porosity and lime or gypsum segregation, profiles have

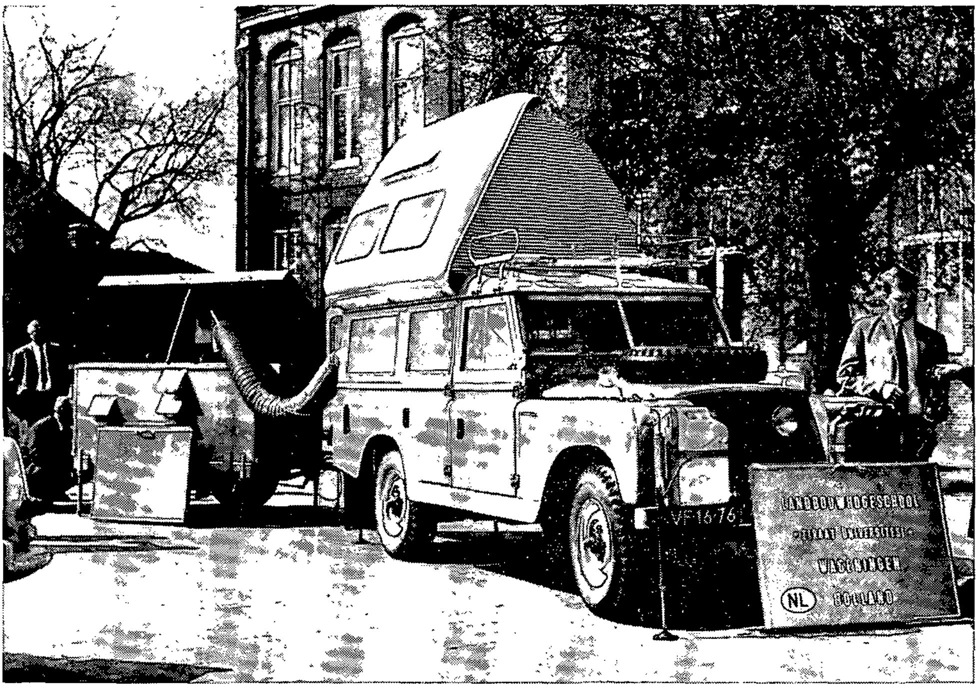
Fig. 85. Preservation of a soil profile as a soil peel.

Şekil 85. Bir toprak profillinin toprak monoliti olarak muhafazası.

been described in detail. In 1967 infiltration rates were measured and the water table was measured twice in about 700 wells, all over the Basin (Chapter 6). Rocks, vegetation and shells were collected for various purposes.

Mobile laboratory A Landrover Dormobile (Fig. 86) was equiped as small laboratory for salinity measurements. Power for light, equipment and air-conditioning was supplied by a 4 kW electric generator. Despite the limited floor space, only 120 × 170 cm, about 20 samples could be analysed each day for anions and cations (including K^+ and Na^+), pH, lime and ECe, representing 200 determinations. The labmobile was also valuable as a field station during missions in remote areas (Driessen & de Meester, Part B).

Fig. 86. Mobile field laboratory. The trailer contains a 4 kW electric generator an air-conditioning plant, a centrifuge and storage space. The tube connecting trailer and Landrover is a cold-air duct. Hydraulic jacks at each corner increase stability.



Şekil 86. Hareketli tarla laboratuvarı. Treyler bir 5 kw'lık elektrik jeneratörü, bir havalandırma cihazı, bir santrifüj ve depoyeri ihtiva etmektedir. Treyleri ve Landrover'i birbirine bağlayan tüp hava-tüpü olarak isimlendirilmektedir. Her köşede stabiliteyi artırmak için hidrolik ayaklar bulunmaktadır.

10.4 Map compilation

Field observations and boundaries were plotted directly on aerial photographs or on tracings of available topographic maps (1 : 25,000). The final map has been drawn on a topographic foundation by reducing the tracings to 1 : 100,000. Direct photographic reproduction of topographic maps was not allowed. The soil map has been reduced to 1 : 200,000 for publication. Transfer of detail from aerial photographs to the topographic base proved very difficult. If photomosaics on the scale 1 : 100,000 had been available, transfer could have been quicker and more accurate. The printed map shows all topography in gray tone and all soil features such as boundaries, symbols and signs in solid black. The colours are superimposed by 3-colour printing as practised by the Netherlands Soil Survey Institute (Stiboka), at Wageningen.

Summary

The Great Konya Basin is an area of internal drainage in the south of the Central Anatolian Plateau in Turkey. Important towns in the area are Konya, Karapınar, Bor, Ereğli, Karaman and Çumra.

Because of its altitude, about 1000 m, the climate is semi-arid with a frostfree growing season of about 170 days, which is too short for rice, cotton, citrus or tobacco. The main crops are dry-farmed cereals and irrigated sugar-beet and melons.

The Basin is tectonic and contains clastic material, which is over 300 m thick here and there and is surrounded by uplands of limestone or volcanic rock. In the Pleistocene epoch the central part was covered by a lake which has silted up, and has been drained since, except for some marshy areas like Hotamış Gölü and Ak Göl. The former lake bottom is now very flat and occupies the central part of the area. Its soils are developed from highly calcareous clay, silt or sandy loam, generally called marl.

About seven rivers discharge into the Basin, mainly from the south and west. They have deposited fluvial material at the fringes and are spreading out over the lacustrine marls. The soils of these alluvial fans and plains have developed from calcareous clays or loams and have weakly developed profiles, usually being classified as Inceptisols. In the backswamp of the River Çarşamba, dark-gray swelling clays with vertic properties have developed.

Along the fringe of the Basin numerous small gullies have deposited piedmont plains or bajadas with reddish-brown clayey soils. The profiles are mainly Alfisols. Coarse-grained colluvial soils cover steeper slopes. Near the volcanic uplands all the alluvial and colluvial deposits contain volcanic mineral grains.

Remains of Neogene structural limestone terraces, which are almost horizontally stratified, occur at several places in the Basin, mainly south of Çumra and west of Karapınar. Their soils are derived from calcareous clay and are old enough to contain a well developed calcic horizon. Most profiles are Aridisols.

The highest terraces are undulating or dissected and the lowest level is flat, waterlogged and consists of soft lime mainly as result of secondary enrichment from carbonate-rich seepage.

The Pleistocene lake shoreline is still visible at many places at about 1017 m as sand and gravel ridges, which are often quarried for building material. South of Karapınar is a large area of active dunes of calcareous medium-sized sand.

Most soils of the Great Konya Basin are salt-affected. Salinity increases downwards from the fringes towards the centre. Degree and type of salinity depend on the hydrology of the area. There is a flow of groundwater through the pervious limestones at the fringe and through the permeable sand and gravel bodies of the alluvial fans. Seasonal fluctuations in watertable are therefore high and consequent salinization in these zones is severe. In the flat centre watertable and salinity do not fluctuate much but vary with slight differences in surface topography.

Salinity is internal in most soils but areas of seepage occur and large depresssions (playas) are external solonchaks. There is a region where chlorides predominate and one where sulphates predominate. Salinity is indicated on the soil map with dots.

Soil suitability is limited mainly by availability of moisture, salt or depth of surface soil. Most soils are ideal in physical properties except for Marl Soils and Soft Lime Soils which contain too much fine earth carbonates, and the Former Backswamp Soils which contain too much smectite clay. Natural soil fertility is moderate because of a large mineral reserve. Preliminary field trials on dry fields in the major soil units indicate that almost all soils respond to phosphorus and partly also to nitrogen. For some soils the response to fertilizer is, however, too small to be profitable in dry farming.

A soil suitability classification was derived from the soil survey. This classification was made for three management systems:

A. Dry farming without fertilizers, capital or skill (the prevailing situation).
B. Dry farming with moderate use of fertilizers, capital and skill.
C. Irrigated farming with ample use of capital, fertilizers and skill.

The results (Table 25) indicate which soils are easiest to improve if a better development management system is to be introduced. A general soil suitability map for System C is produced.

The soils of the Great Konya Basin are mapped on the scale 1 : 200,000. The mapping units are on soil association level, but a further division into soil phases was often possible. Maps of sample areas show the soil series which go into the associations or complexes in several parts of the area. The map legend is based on physiography. The soil survey has been carried out mainly in the field but was supported by a systematic interpretation of aerial photographs by stereoscope.

An attempt has been made to relate representative profiles to the newest USDA taxonomic classification (7th Approximation, 1964 and 1967 supplements).

Özet

Dış drenajı olmayan büyük Konya Havzası, Türkiye'nin Orta Anadolu Plâtosunun Güney kısmında bulunmaktadır. Bölgede en önemli şehir ve kazalar Konya, Karapınar, Bor, Ereğli, Karaman ve Çumra'dır.

Bölgenin deniz seviyesinden 1000 metre yüksek oluşu dolayısiyle pirinç, pamuk, turunçgiller veya tütün yetişmesi için kısa geçen donsuz yetiştirme süresi yaklaşık olarak 170 gün olan yarı kurak bir iklime sahiptir. Esas yetiştirilen bitkiler kuru ziraat hububatları, sulanan şeker pancarı ve kavundur.

Havza tektonik olup çeşitli yerlerde 300 metre kalınlığı aşkın klastik materyal ihtiva etmektedir. Etrafında kireç taşı veya volkanik yüksek araziler bulunmaktadır. Pleistosen devrinde merkezi bir göl tarafından kaplanmış, sonradan dolmuş, Hotamış Gölü ve Ak Göl gibi bataklık sahalar hariç, drene olmuş ve kurumuştur. Önceki göl tabanı düz olup çalışma sahasının merkezini kaplamaktadır ve toprakları genellikle marn olarak adlandırılan fazla kireçli kil, silt veya kumlu tından teşekkül etmiştir.

Havza, daha ziyade güneyden ve batıdan yedi çay tarafından beslenmektedir. Bu çaylar havzanın kenarlarına ve ortasına doğru aynı zamanda lakustrin marnlar üzerine fluviyal materyal yığmışlardır. Bu aluviyal yelpazelerin ve ovaların toprakları kalkerli killer veya tınlar içinde oluşmuşlardır ve zayıf profil gelişmesine sahip olmakla genel olarak, Inceptisol'lere girmektedirler. Çarşamba nehrinin Bataklık Ardı, koyu gri şişen killeri vertik özelliklerle oluşmuşlardır.

Havzanın çevresi boyunca çok sayıda küçük galiler, kırmızımsı kahverengi killi toprakları ihtiva eden piedmont ovalar veya bayadalara materyal yığıştırmışlardır. Profiller genel olarak Alfisol'lere girmektedirler. Daha dik eğimler boyunca kaba parçalı koluviyaller mevcuttur. Volkanik yüksek arazilerin yakınlarında bütün koluviyal ve koluviyal birikintiler, volkanik mineral parçalarını karışık olarak ihtiva ederler. Hemen hemen yatay olarak yığılmış neojen strüktürel kireç taşı teraslarının artıkları daha çok Çumra'nın güneyinde ve Karapınar'in batısında olmak üzere havzanın pek çok yerlerinde bulunmaktadır. Bunlardan teşekkül eden topraklar kireçli killerdirler ve iyi bir 'calcic' horizonun oluşumuna yetecek kadar yaşlıdırlar. Pek çok profiller Aridosol'dürler.

Erozyon dolayısiyle en yüksek seviyeli teraslar ondülelidirler veya yarılmışlardır ve en alçak seviyeliler ise düz, suya doygun ve genellikle ikincil olarak karbonatlı sızıntılardan zenginleşmiş yumuşak kireçten, meydana gelmişlerdir. Yapı materyali için genellikle kazınmış olan kum ve çakıl bentleri halinde pek çok yerlerde yaklaşık olarak 1017 metre yükseklikteki Pleistosen gölün kıyısı izlenebilir. Karapınarın güneyindeki geniş bir sahada aktif orta büyüklükte kireçli kum kümeleri bulunmak-

tadır.

Büyük Konya Havza'sının toprakları genel olarak tuz etkisindedir. Tuzluluk; derinlik ile ve kenardan merkeze doğru artmaktadır. Tuzluluk derecesi ve tipi tamamen bölgenin hidrolojisine bağlıdır. Porözlü kireç taşlarında, aluviyal yelpazelerde, geçirgen kum ve çakıl kitlelerinde taban suyu akışı mevcuttur. Netice itibariyle, bu bölgelerde mevsimlere bağlı taban suyu ve tuzlulaşmadaki değişiklikler fazladır. Az olarak yatay taban suyu akışı da mevcuttur. Düz olan havza merkezinde taban suyu yüksektir ve yüzey topoğrafyasındaki hafif değişmelerle tuzluluk değişmektedir.

Tuzluluk pekçok topraklarda içeridedir. Fakat dış solonçaklar sızmaların olduğu geniş çukurlarda (playalarda)bulunmaktadır. Esas olarak klorürlerden oluşmuş yerler (kazalar) Çoğunluktadır ve bir kaza merkezinde genellikle sulfatlar vardır. Tuzluluk toprak haritasında noktalarla işaret edilmiştir.

Toprak elverişliliği daha çok elverişli nem, tuz veya yüzey toprağının derinliği tarafından tanzim edilmektedir. Smektit kili fazlaca ihtiva eden bataklık ardı, çok ince karbonatları ihtiva eden yumuşak kireçler ve marnlar hariç olmak üzere, pek çok topraklar uygun fiziksel özelliklere sahiptirler. Geniş mineral kaynaklarına sahip olmaları dolayısiyle tabii verimlilikleri oldukça iyidir. Hakim toprak ünitelerinin kuru tarlalarında yapılan ilk tarla denemeleri hemen hemen bütün toprakların fosfora ve kısmen nitrojene tepki gösterdiklerini işaret etmiştir. Bazı toprakların gübrelere karşı tepkisi ekonomik değildir.

Toprak etüdünden yorumlanarak bir toprak elverişlilik sınıflandırılması yapılmıştır. Bu sınıflandırma 3 amenajman sistemi için kurulmuştur.

A. Sermaye veya ustalıkla sun'i gübresiz kuru ziraat (sulanan sahalar hariç olmak üzere bugünkü hakim durum).

B. Sermaye ve ustalıkla orta derecede sun'i gübrenin kullanılmasiyla kuru ziraat.

C. Bolca sermaye, sun'i gübre ve ustalık kullanılarak sulu ziraat. Sonuçlar; eğer bir şahıs daha iyi gelişmiş amenajman sistemi takdim etmek isterse, hangi toprakların gelişmeye uygun olduğunu işaret etmektedir. (Tablo 25).

Büyük Konya Havza'sı toprakları 1/200 000 ölçekle haritalanmıştır (Harita. 1). Haritalama üniteleri toprak birlikleri seviyesindedir. Fakat toprak fazları olarak alt bölümler pek çok kere mümkün görülmüştür. Toprak serileri seviyesindeki örnek saha haritaları (Harita 2) toprak birliklerinin veya komplekslerinin sahanın birçok yerlerindeki bileşimini göstermektedir ve harita lejantı fizyografiye dayanmaktadır. Fakat stereoskopla sistematik hava fotoğrafları yorumlanmasından yararlanılmıştır.

Her bir haritalama ünitesini, en yeni A.B.D. taksonomik sınıflandırması (ilâveleriyle yedinci tahmin) terimleriyle ifade etmek için teşebbüste bulunulmuştur.

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Part B

Results of special studies

Mineralogy of heavy clay from Former Backswamp Soils of the Great Konya Basin

L. van der Plas & R. Schoorl

Abstract

Former Backswamp Soils are carbonate-rich alluvial soils at the base of the Çarşamba Fan. They swell severely when wetted and their profiles have vertic features. Some 60 samples collected from transects in the Çumra Area were analysed with a diffractometer. Detailed results by powder photography and cation-exchange capacity were given only of 4 samples selected on a geographic basis.

The samples could be divided in 3 clay-mineral groups: a smectite-rich group, a chloride-rich group and a mica-rich group. These results supported the soil survey because the distribution of each group corresponded fairly well with the mapping units.

Introduction

Former Backswamp Soils are carbonate-rich alluvial soils at the fringe of the Çarşamba Fan and merge into the Marl Soils of the Lacustrine Plain. They swell severely when wetted. This vertic property is due to the presence of minerals of the smectite group.

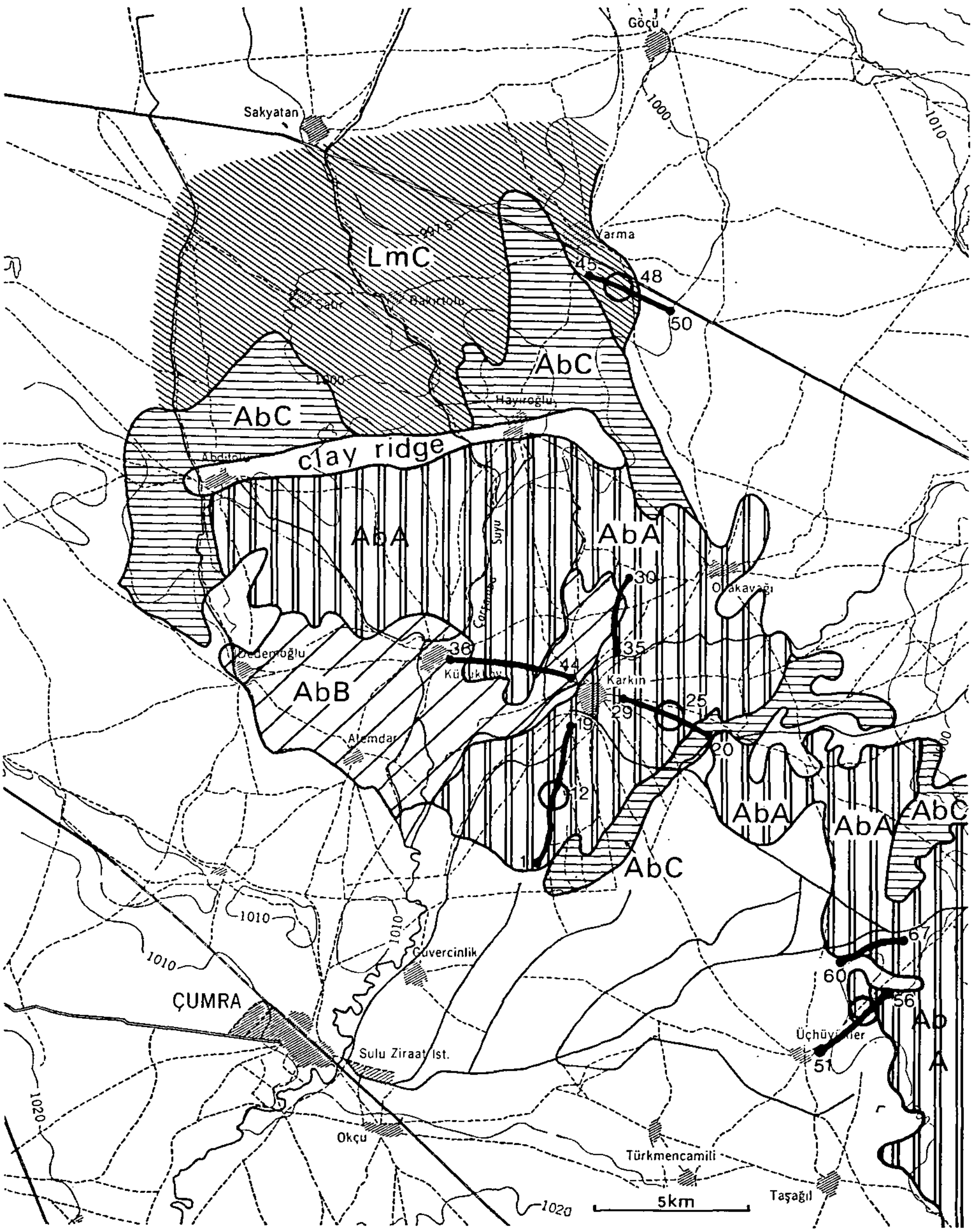
In 1965, 61 samples of soil between 10 and 20 cm from the surface were collected from transects of Former Backswamp Soils and adjoining units near Karkin, Üçhüyükler and Yarma (Fig. 1). All the samples were analysed with a diffractometer but detailed results are given here of only 4 samples representative of the different areas (Table 1) which were more closely studied by powder photographs and by cation-exchange capacity.

All samples were rich in carbonates. At least 50% of the carbonate-free residue consisted of particles smaller than 2 μm and usually less than 10% exceeded 50 μm in particle size.

Methods

Clays so rich in carbonate need special preparation for mineralogical analysis. Organic matter was removed from the sieved air-dried samples with hydrogen peroxide, and calcium and magnesium carbonates with hydrochloric acid (van der Plas, 1966). After peptization with sodium hydroxide, the fraction finer than 1 μm was separated by a settling technique.

Fig. 1. Distribution of former Backswamp Soils and sample traverses with fieldnumbers.



Şekil 1. Eski bataklık ardı topraklarının dağılımı ve tarla numaralariyle beraber örnek traverslerin yerleri.

Table 1. Particle size distribution after removal of carbonates and carbonate content (calculated as $CaCO_3$ per 100 g dried soil) of four samples of predominantly grayish swelling clayey Former Backswamp Soils (Unit AbA), Clayey Marl Soils with shell fragments (Unit LmA) and Clayey Çarşamba Soils (Unit AcA). Sites of sampling are marked on Fig. 1.

Field site	Unit	Particle-size distribution %						$CaCO_3$ %
		> 50μm	32–50μm	16–32μm	8–16μm	2–8μm	< 2μm	
12	AbA	6.9	2.8	10.0	3.5	12.5	64.6	12.5
25	AbA	7.2	3.3	6.2	6.8	26.5	50.0	21.8
48	LmC	3.5	8.1	3.1	6.2	12.4	66.7	47.7
53	AcA	8.0	6.7	4.6	1.8	17.7	61.2	20.8

Tablo 1. Hakim olarak, şişen önceki bataklık ardı toprakları (AbA ünitesi), fosil parçaları ihtiva eden killi marn toprakları (LmA ünitesi) ve killi Çarşamba nehri yelpazesi toprakları (AcA ünitesi) ndan dört örneğin karbonatların giderilmesinden sonra parça büyüklüğü dağılımı ve karbonat miktarları (100 gr kuru toprakta $CaCO_3$ olarak hesaplanmıştır). Toprak örneklerinin alındığı yer şekil 1 de gösterilmiştir.

For X-ray analysis subsamples from all 61 soils were saturated with calcium, potassium and magnesium in the usual manner. Cation-exchange capacity was estimated in the 4 samples by the method of Yaalon *et al.* (1962); clays were saturated with lithium which was determined by flame photometry.

For X-ray analysis slurries of the calcium, magnesium and potassium clays were smeared onto glass slides and kept at 50% relative humidity until the diffractometer traces were made. Calcium and magnesium clays on similar slides were treated with glycerol. Calcium clays on stainless steel slides were heated at 550°C for 30 minutes.

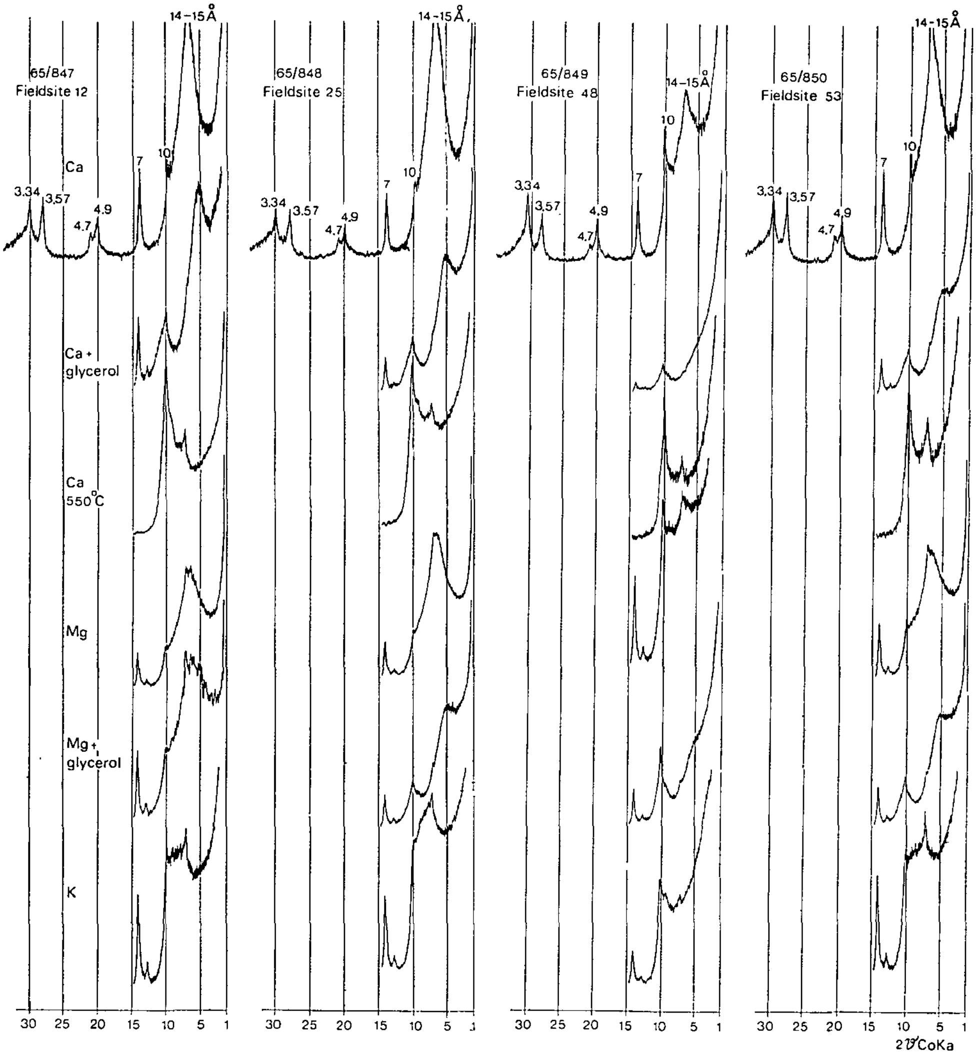
To simplify comparison, all the diffractometer traces were made with cobalt radiation at a rate meter setting of 32, a time constant of 2 seconds and a goniometer speed of 1° per minute.

Powder photographs were made with cobalt radiation and a quadruple Guinier de Wolff camera. Samples of air-dried clay fractions were prepared as for the slides for diffractometer traces. Some samples were mixed with stopcock grease (a vacuum grease), but for other photographs and traces the clays were expanded with glycerol before smearing onto the sample holder. To intensify the basal reflections the paste smears were always scratched as proposed by Porrenga (1958). These photographs enabled us to estimate the proportion of the various minerals in the sample by comparing them with photographs of artificial mixtures and with photographs of samples whose mineral composition had been studied in greater detail. Our experience suggests these estimates are accurate within 10%.

Results of X-ray analysis

The traces prepared in each of the 6 manners were similar between the 61 samples as would be expected in such a uniform area (Fig. 2). They were rich in a swelling 14Å mineral and had some 10Å and 7Å minerals. In all 4 samples the 7Å reflexion disappeared after heating while the 14Å reflection persisted. With glycerol the 14Å

Fig. 2. Diffractometer traces of samples 65/847, 65/848 and 65/849 and 65/850 with different cations and different treatments.



Şekil 2. Çeşitli katyonlar ve çeşitli muamelelerle 65/847, 65/848, 65/849 ve 65/850 numaralı örneklerin difraktometre izleri.

reflection of calcium and magnesium clays shifted towards 19Å but a small 14Å reflection persisted; swelling of magnesium clays was similar to that of calcium clays. Potassium clays showed a small rather sharp reflection at 14Å and a region between 10Å and 14Å of increased intensity.

Mineralogical composition of the clay fraction

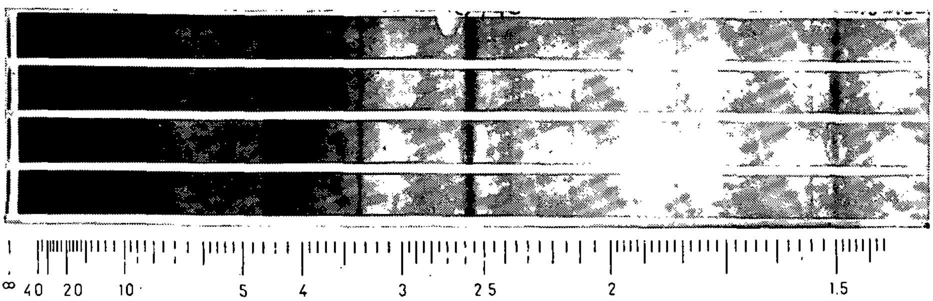
The traces (Fig. 2) and the Guinier photographs (Fig. 3) can be interpreted as follows. Quartz content of the clay fraction is less than 10%. Swelling and non-swelling mica clay minerals are dioctahedral; dioctahedral hydrous micas reach 50%. Kaolinite, of which there is little, seems to be disordered. Vermiculites, however defined, are absent. The 060 reflexion at 1.5Å indicates the presence of dioctahedral smectites. Chlorite minerals are at most 10%. Guinier patterns were surveyed and the

Table 2. Rough percentage composition calculated by comparing the Guinier patterns with those of known samples

Field site	Smectite + chlorite	Mica	Kaolinite	Quartz
12	40	30	25	5
25	50	25	20	5
48	25	50	20	5
53	35	35	25	5

Tablo 2. Bilinen örnekler kullanarak Guinier paterni ile karşılaştırmakla hesaplanmış kaba bileşim yüzdesi.

Fig. 3. Guinier-De Wolff diffractograms of the four clay samples. Cok X radiation. The scale is in Å. From above to below: 65/847, field site 12; 65/848, field site 25; 65/849, field site 48; 65/850, field site 53.



Şekil 3. Dört kil örneğinin Guinier-De Wolff difraktogramı. Cok X radiasyonu. Ölçek angström olarak verilmiştir.

Table 3. Cation-exchange capacity (in meq per 100 g) of the clay fraction of 4 samples estimated experimentally by the method of Yaalon *et al.* (1962) and mean and range calculated from Grim's values (1953) for the pure minerals and the mineralogical composition as in Table 2.

Field site	Experimental CEC	Calculated CEC	
		mean	range
12	52.6	56.5	36–78
25	53.9	65.5	44–90
48	45.2	43.5	26–62
53	47.5	49.0	33–67

Tablo 3. Yaklaşık olarak Yaalon ve arkadaşlarının (1962) metoduyla, ortalama ve tanzim edilerek hesaplanmış Grim'in hacımları (1953) ndan hesaplanmış dört kil fraksiyonunun katyon değişim kapasitesi (meg/100 g olarak).

Table 4. Peak area percentages of the diffractogram traces of calcium clay fractions from 4 soil samples

Field site	Smectite + chlorite	Mica-like	Kaolinite	Quartz
12	81.0	9.2	8.1	1.7
25	86.5	7.3	3.7	2.5
48	74.7	15.9	7.6	1.8
53	79.4	11.4	6.6	2.6

Tablo 4. Dört toprak örneğinde kalsiyum killerinin difraktogram izlerinin pik (peak) sahası yüzdeleri.

proportions of minerals estimated (Table 2). The accuracy of the estimates can be judged by the agreement between the cation-exchange capacity (Table 3) estimated experimentally and that calculated from the cation-exchange capacities of the pure minerals given by Grim (1953): smectite 80–150, mica 10–40, kaolinite 3–15, chlorite 10–40 meq per 100g.

Peak area percentages (Porrenga, 1967) (Table 4) gave similar results to the Guinier patterns in terms of ranking the importance of the various minerals. Peak area percentages exaggerated the amount of smectite; hydrous micas were underestimated, especially if poorly crystallized. This property of analysis on oriented smear mounts is well known. Guinier patterns gave better quantitative values, which were consistent with values for cation-exchange capacity if samples contained little amorphous material.

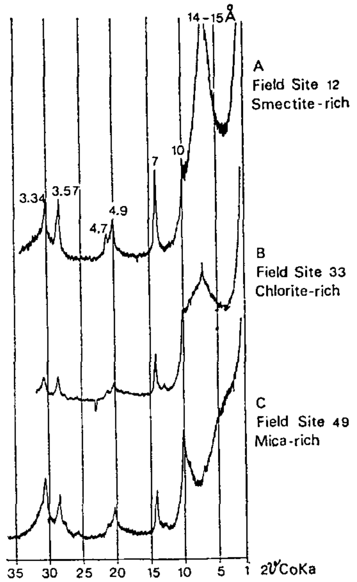


Fig. 4. Diffractometer traces of the three main clay mineral associations.

Şekil 4. Üç esas kil minerali birliğinin difraktometre izleri.

Distribution of clay minerals in the soil units

The diffractometer traces of the 61 samples showed that they fell into 3 groups (Fig. 4), of which, unfortunately, only Group A was represented in the 4 samples chosen on a geographical basis for detailed study.

Group A, the smectite-rich group, had a strong broad reflexion at 14.5Å: Samples 1–32, 40, 42, 45, 48, 52–61.

Group B, the chlorite-rich group, had a strong broad reflexion at 12–18Å and a sharp maximum at 14.5Å: Samples 33–34, 36–37, 39, 41, 43–44, 47, 50–51.

Group C, the mica-rich group, had a strong reflexion at 10Å, characteristic for both mica and hydrous mica: Samples 35, 38, 46, 49.

The smectite-rich clays came from all the areas sampled, mainly Unit AbA (predominantly grayish swelling clayey Former Backswamp Soils); near Karkin they also fell into Unit AbC (mainly moderately deep non-swelling clayey or loamy Former Backswamp Soils over soft lime or marl); near Üçhüyükler all but one of the samples taken from Units AbA and AcA (Clayey Çarşamba Fan Soils) fell into this group.

The chlorite-rich samples also came from all areas; near Karkin they were concentrated in Unit AbB (predominantly brownish swelling clayey Former Backswamp Soils) and one near Üchhüyükler came from Unit AcA. They were mostly slightly better drained and less subject to vertic processes. Mica-rich samples came from the boundaries of units AbA and AbB near Karkin and from near Yarma.

The complexity of the three mineral types near Yarma at the boundaries of units AbC, LmA and LmC confirms field observations. The fan's fringe consists of thin irregular alluvial sediments of various origin, alternating with local organic deposits.

Özet

Önceki bataklık ardı toprakları, karbonatça zengin Çarşamba nehri fan'ının alçaklarda temelini teşkil eden, alluviyal topraklardır. Islandıkları zaman şiddetle şişmektedir ve profilleri vertik özelliklere sahiptir.

Çumra havalisinde yapılan kesitlerden 60 örnek toplanmış ve difraktometre ile analizleri yapılmıştır; fakat toz fotografi ve C.E.C. üzerinde değişik sahaları temsil eden yalnız 4 örneğin sonucu verilmiştir.

Örnekler 3 mineral grubu içinde toplanabilir: smektitçe zengin grup, kloritçe zengin grup ve mikaca zengin grup. Her grup topografik olarak aşağı yukarı değişik harita ünitelerine tekabül ettiğinden, bu sonuçlar toprak etüdüne yardım etmektedir.

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Genesis and morphology of reddish-brown soils of the Great Konya Basin[1]

T. de Meester & J. van Schuylenborgh

Abstract

Mainly at the western fringe of the Great Konya Basin, south of Konya, piedmont plain or bajada deposits occurred with reddish-brown soils. These deposits had been transported only 6 km from the Cretaceous Limestone uplands, now entirely denuded.

A transect was made from top to bottom and its profiles were studied chemically and morphologically. There was evidence that the Bajada Soils consisted of material originally situated on the limestone hills as red mediterranean soil (Terra-Rossa) and that this material had moved downhill as mudflows. The Bajada profiles exhibited two well developed series of A–B horizons on top of each other, each with an A1, an argillic and a calcic horizon, suggesting sedimentation in two periods with a longish interval.

Introduction

At the western fringe of the Great Konya Basin, between Konya and Karaman, clayey reddish-brown (2.5YR 4/4) fluvial piedmont plain or bajada deposits were mapped. They differed in colour from the loamy brown Bajada Soils in other parts of the Basin's fringes. See Part A, Chap. 5.

This material seems to have derived from Cretaceous limestone under a climate different from the present one and the profile seems to have developed since they were deposited. For comparison a Terra Rossa profile from the coast of Yugoslavia was analysed. To study their genesis and morphology 7 profiles from a large isolated gully fan in the Basin were described in a transect down the slope (Fig. 1). A profile characteristic for the most of the deposit is here discussed (Fig. 2).

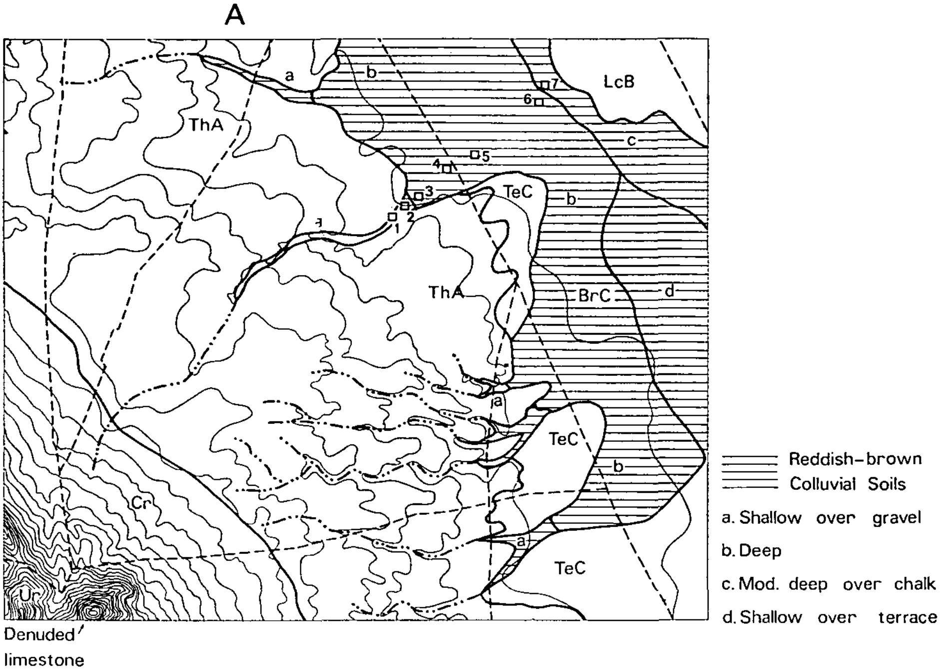
Residual soil from between rocks and rocks themselves from nearby hilltops were taken and analysed at Wageningen. Structure and morphology were studied both in the field and with soil peels at the laboratory.

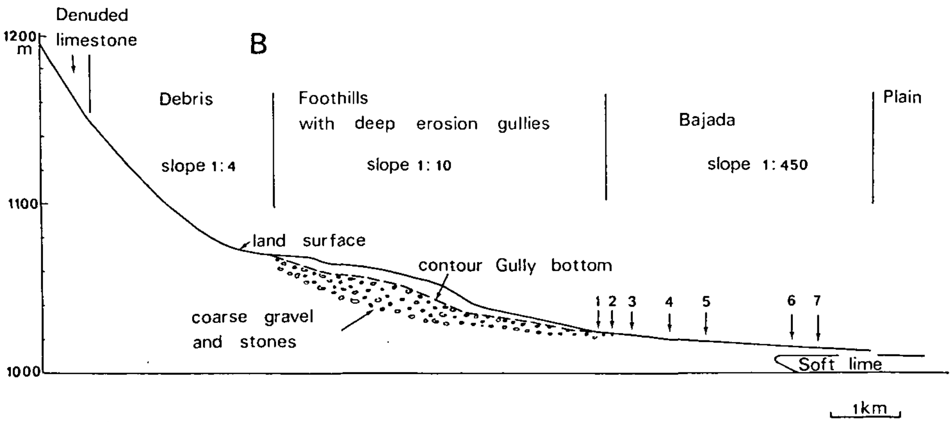
Geogenesis, physiography and distribution

These deposits have been transported 6 km from the Cretaceous limestone hills (now entirely denuded) into the Basin. They came down through numerous shallow

1. Paper presented to the Conference on Mediterranean Soils, Madrid, 1966.

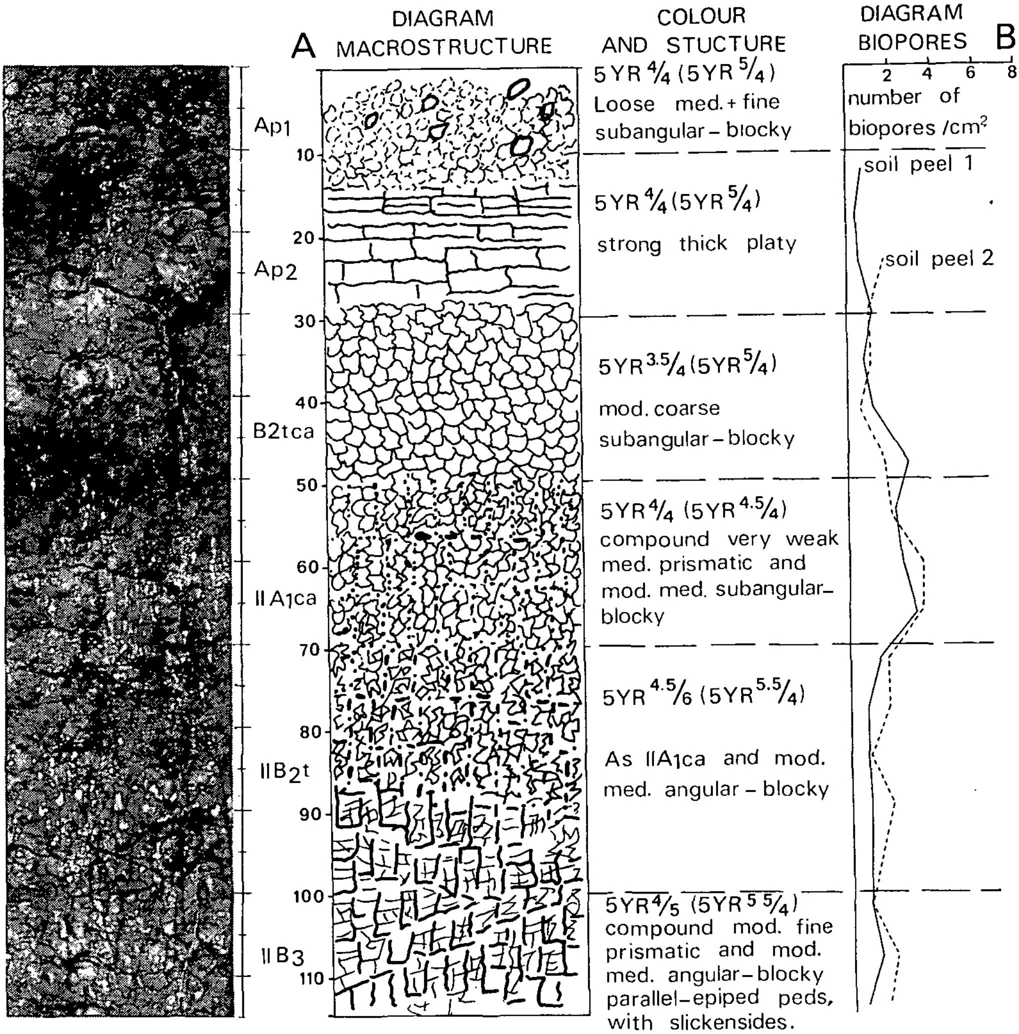
Fig. 1. Distribution of reddish-brown colluvial Bajada Soils south of Konya. A) Map with points 1–7 on the transect marked by squares.
B) Crossection of the fringe of the Basin.





Şekil 1. Konyanın güneyinde kırmızımsı kahverengi kolluviyal Bajada topraklarının dağılımı.
A. Kare şeklinde işaretlenmiş 1–7 noktaların meydana getirdiği kesiti gösteren harita.
B. Havzanın kenar kesiti.

Fig. 2. Profile point 4. Diagrams of the macrostructure (A) and of the number of biopores per sq. cm (B). The average of 5 × one cm² is counted at 2 different soil peels of the same profile point.



Şekil 2. 4 numaralı profilin makro struktur diyagramı (A) ve her cm² için biyoporların sayısı (B). Aynı profilden alınan 2 değişik toprak monolitinde her cm² için ortalama 5 sayılmaktadır.

gullies on the steep hillside into a few deeply incised gullies in the undulating foothills and were disgorged into a nearly level fan in the Basin. (See also part A Fig. 30). Such bajadas occur along the whole western fringe of the Konya Basin between Konya and Karaman. We have noticed similar deposits in similar basins or valleys between denuded limestone hills throughout Central and Mediterranean Anatolia. South of Konya about 6 main gullies enter the Basin within a distance of 9 km, forming a belt of

Table 1. Analytical data of Profile point 4.

Horizon	Depth (cm)	Fraction < 2μm	C (%)	$CaCO_3$eq. (%)	pH		Sio_2/Al_2O_3		SiO_2/Fe_2O_3		Al_2O_3/Fe_2O_3	
					H_2O	$CaCl_2$	soil	clay	soil	clay	soil	clay
Ap1	0– 15	51.2	0.84	12.1	8.00	7.50						
Ap2	15– 30	58.1	0.52	13.6	8.16	7.52	5.81	4.15	21.6	14.8	3.73	3.56
B2tca	30– 50	61.2	0.43	18.3	8.23	7.55						
IIA1ca	50– 73	53.7	0.62	14.8	8.32	7.61	5.70	4.48	21.8	15.5	3.82	3.45
IIB2t	73–100	61.3	0.30	21.0	8.35	7.75						
IIB3	103–130	54.9	0.23	23.6	7.70	7.70	6.33	4.26	22.6	15.4	3.56	3.60

Tablo 1. Profil 4 hakkında analitik bilgiler.

coalescing fans. This belt is on average about 2 km wide. The deposit thins out over the Soft Lime Plain (TcA). Locally, the deposit covers remnants of a truncated Terrace Soil.

The position of these profiles is indicated in Fig. 1. The gradient of the channel from the Uplands to the fridge of the fan ranges from about 1 : 4 at the apex to 1 : 450 at the base so that there is very little erosion down slope. After heavy rain some rill erosion was observed.

The transect

The bajada deposit was clayey (50–60 % $< 2\ \mu m$) with 3–4 % coarse and very coarse sand, reddish-brown to yellowish-red (5YR 4/5 when wet, 5YR 5/5 when dry). The subsoil was usually redder, sometimes even dark-red (2.5YR 3/6).

Point 1 in the gulley had a shallow surface soil and Point 2 at the apex of the fan a moderately deep surface soil, both over gravel and pebbles, mixed with some clay. Lime had segregated only as pseudomycelium in the surface soil.

Points 3, 4 and 5 had deep soils and a subsoil with vertic features such as small slickensides and parallelepipedal and wedge-shaped structure elements. As Point 4 had the most characteristic profile, it is described in full in Part A, Profile 12. The macrostructure is drawn by Jongerius's sytem (1964) and the biopore diagram by the method of Slager (1964) is shown in Fig. 2 and Table 1 repeats some essential analytical data.

Point 6 had deep and Point 7 moderately deep surface soils over very calcareous subsoil of Soft Lime Soil over which the Bajada fans out. Their lower elevation and higher watertable gave the surface and subsurface horizons at Point 6 and particular at Point 7 distinctive characteristics. The soil was silty clay rich in carbonate (20–30 %) and lighter in colour: brown to dark-brown (7.5YR 5/4) when wet and pale-brown (10YR 6/3) when dry.

The surface horizon at all the points contained fresh and old insect holes, the latter filled with faecal pellets often standing out in the profile as globular or sausage-shaped biogenetic structures (aggrotubules). Krotovinas filled with crumb soil were also common at all points mainly in subsoil.

Field observations and soil peels showed an increase in biological activities of insects, worms and rodents from apex to base of the fan.

As to land-use, Points 2–5 were under dry-farmed wheat. At Points 6 and 7, the soils were moist to the surface but not saline even in summer, so they were commonly used for market-gardening.

Origin of the soils

The physical and chemical data and the morphology of the profile suggest that the soils were formed during two periods of sedimentation, separated by a break. The two deposits are indicated in the profile description by a roman I and II. It is not clear whether the subsoil (indicated with roman III) is a remnant of some very old soil formation. It might belong to deposit II. The recognition of I and II is based on the breaks in content of clay and organic matter, clay composition, distribution of biopores and carbonates. A calcic and argillic horizon have been found in both deposits I and in II. The formation of such horizons takes time, hence the presumed break in sedimentation.

The occurrence of slickensides only in the subsoil deeper than 100 cm is peculiar because the clay mineral composition of the soil is rather uniform. The minerals present are predominantly montmorillonite, with small admixtures of illite, kaolinite and quartz. A reason could be that the upper part of the soil is dry for so long that it swells and shrinks less than the subsoil, which is moist for more of the year. Slickensides form by large fluctuations in moisture content over considerable time.

Another question is whether the deposits could have originated from weathered limestone in a moister climate resembling a Mediterranean one. During the Pleistocene Era the climate certainly was much more humid than now (Butzer 1958).

To try to answer this question the composition was compared of residue from limestone digested in dilute acid and weathered material from protected cracks and Bajada Soil in the studied area of Turkey and a characteristic Terra Rossa in Yugoslavia. The

Table 2. Silica-sesquioxide ratio in the whole material of limestone anu weathered residual soil from the Uplands above the part of the Konya Basin studied, Bajada Soil from the Basin and Terra Rossa from Split, Yugoslavia.

Material	SiO_2/Al_2O_3	SiO_2/Fe_2O_3	Al_2O_3/Fe_2O_3
Limestone fragments (Turkey)	4.6	17.8	3.9
Weathered limestone (Turkey)	5.2	18.0	3.5
Bajada (Turkey)	5.8	22.0	3.8
Terra Rossa (Yugoslavia)	6.5	23.0	3.5

Tablo 2. Kireç taşı bütününde ve üzerinde çalışılmış Konya havzasının yüksek kısımlarında tecezzi etmiş resudial toprakta, havzada bajada toprağı ve Split (Yugoslaviya)'te Terra-Rossa'da silisyum dioksit, seskioksit oranı.

Table 3. Silica-sesquioxide ratio in clay separates of various materials

Material	SiO_2/Al_2O_3	SiO_2/Fe_2O_3	Al_2O_3/Fe_2O_3
Weathered limestone (Turkey)	3.6	13.0	3.5
Bajada (Turkey)	4.3	15.0	3.5
Terra Rossa (Yugoslavia)	2.3	9.0	3.9

Tablo 3. Kil de silisyum dioksit, seskioksit oranı.

Yugoslavian Terra Rossa was derived from a limestone identical in composition to the Turkish limestone. Conclusions remain preliminary, however, because few samples were investigated.

The composition is characterized by the ratio silica to sesquioxide (Table 2). The composition of the weathered material presumed to be formed from the limestone is different from that of the digested limestone residue because more aluminium than silica and iron is dissolved and removed during natural weathering of limestone. Erosion and sedimentation may have resulted from deforestation and a change to a drier climate. Thereafter the material has been subject to a differential removal of Al and Fe, leading to soil materials with more silica in relation to sesquioxides. The silica has become less soluble because of seasonal drying of the soil.

The limestone-derived soil in Yugoslavia, however, has remained subject to a wetter climate so that leaching has continued and more iron and aluminium has been eluted. The composition of the clay fraction (Table 3) also reflects this difference.

The clay minerals in the soils developed in the Bajadas have changed into a purer type of smectite because of the high base status of these soils, whereas those in the Terra Tossa have changed into mainly kaolinites because of stronger leaching.

Özet

Büyük Konya havzasının daha ziyade batı kenarında, Konya'nın güneyinde 'Piedmont Ova' veya 'Bajada' depositleri üzerinde kırmızımsı-kahverengi topraklar bulunmaktadır. Bu depozitler sadace 6 km mesafeden halihazırda çıplak kretase kireç taşlarıyla kaplı yüksek arazilerden taşınmışlardır.

Yüksek kısımlardan tabana doğru bir kesit yapılmış ve profiller kimyasal ve morfolojik olarak incelenmiştir. Aşikâr olan şu ki bajada topraklarının materyali, aslında kireç taşlariyle örtülü tepelerde Kırmızı-Akdeniz toprakları olarak bulunurken, topraklar ve materyallerin tepelerden aşağıya doğru çamur akıntısı olarak taşınmış olmasiyle meydana gelmişlerdir. Bajada profilleri, iki seri, iyi gelişmiş, birbiri üzerinde herbiri A–B, A1, argillik, kalsik horizonlarını havi iki ayrı sedimantasyon devresi ve bu iki devre arasında nisbeten uzun bir devrenin geçmiş olduğu fikrini veren özellikler göstermektedir.

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Investigations on soil moisture and dry-matter production in the Great Konya Basin

B. H. Janssen

Abstract

In the Great Konya Basin a system of dry wheat and fallow is the common form of arable farming used to conserve moisture.

Fertility studies on important soil units included a water-conservation study; soil moisture was recorded at the start, middle and end of the growing season in 1966, 1967 and 1968. From completed data a relationship between stored moisture and dry-matter production was calculated. Also the transpiration was calculated and related to the dry-matter production.

Differences in stored moisture occur between different soils because of their physical properties but also because of variable precipitation and differences in watertable. The rainfall in April and May determined the yield above a certain minimum. Yet water conservation by the fallow year proved to be important for total production of dry matter and especially for the grain/straw ratio which improved with increasing available water.

Purpose and methods

In Turkey a dry wheat-fallow system is the most widespread form of arable farming, used to conserve moisture for crop production in the following year. Exact data of the effect of fallow are rare. Preliminary studies were made by Özbek *et al.* (1967). They found an efficiency of fallow (*i.e.* the proportion of precipitation in the fallow year conserved in the soil) of 20–22% for clay soils and of 12–19% for clay-loam soils. In America Evans & Lemon (1957) mention about the same percentages.

These figures suggest that the efficiency of fallow is rather low and the question arises whether the fallow year should be abandoned.

In the arid climate of the Great Konya Basin, moisture is assumed to be the most important yield-limiting factor. Therefore research on soil fertility and water conservation must be integrated. As stated in Chapter 7 of Part A soil moisture content was estimated during the fertility trials at least three times in October (sowing time), in May and in July (harvest time). The moisture content by weight was estimated by drying at 105°C. Also the volume weights (bulk density) of the different horizons have been estimated (using core samples of 100 cm^3) and by multiplication of moisture content by weight with the volume weight, moisture content by volume or in mm has been calculated.

Results and discussion

Phase distribution and moisture content

For the Terrace Soils (TeB and TeC), reddish-brown Limestone Bajadas (BrA) and Marl Soils (LmA) the average phase distribution to a depth of 120 cm has been calculated, the Marl Soils being divided in marls near Konya and marls near Hotamış (Part A, Chapter 7).

Figure 1 gives the phase distribution diagrams. It appears that the Terrace Soils are the most porous, pore space varying between 53 to 60 %. The topsoil of the Marl Soils is more porous than of the reddish-brown Limestone Bajadas to about 60 cm, but the porosity at greater depth is nearly the same (45-47 % pore volume). Marl near Konya is between 20 and 60 cm more porous than marl near Hotamış.

The average moisture contents in October and the next July are also shown in Figure 1. The difference between the curves for both dates is the stored water. As the upper 20 cm of the profile looses much of its water when under crops or fallow, this decrease is assumed to be due to evaporation and only the moisture stored deeper than 20 cm is assumed to be transpired by plants. The crops seem to withdraw water also from deeper than 120 cm except for the Marl near Hotamış. Hence in 1968 samples were taken to a depth of 200 cm.

Table 1 gives assessments of the stored moisture used for transpiration from the 20–120 cm and 120–200 cm layers.

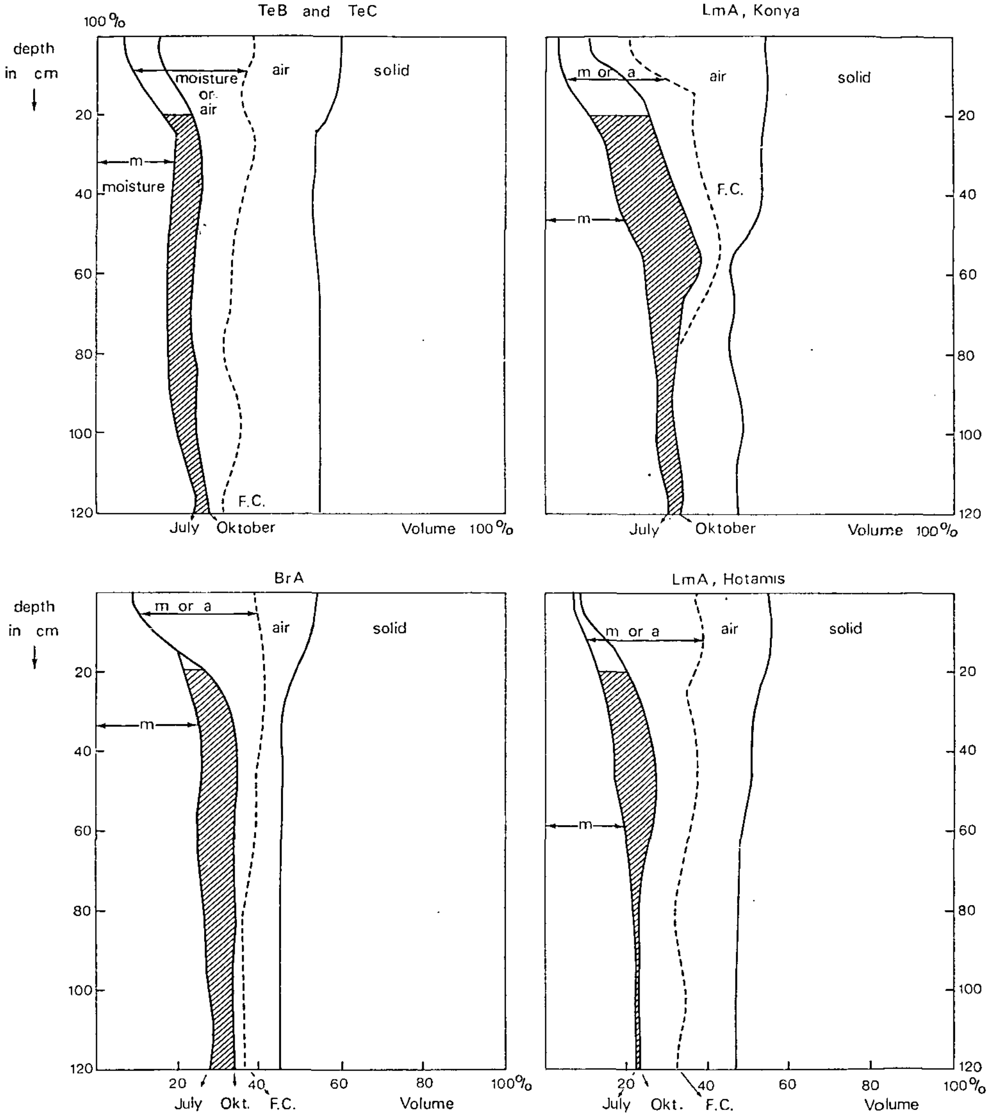
The contribution of the subsoil is the highest for reddish-brown Limestone Bajadas. Crops on Marls (Hotamış) do not withdraw moisture from more than 90 cm. Perhaps on reddish-brown Limestone Bajadas moisture can be taken up from more than 200 cm, but the amount is calculated to be low (about 10 mm).

In 1968 the field capacity was estimated on the following way (on 5 profiles: LmA Kon, LmA Hot, TeC and 2 times BrA).

Two steel cylinders, each with a diameter of 40 cm and a height of 16 cm, were placed on the soil and filled with water. In total about 50 litres water was used, corresponding with about 400 mm. As the water moves not only downwards but also sideways the net amount of water penetrating into the soil column of 40 cm diameter is lower. If an average wet diameter in soil is assumed of 80 cm, 100 mm water penetrated into the 40 cm column. After wetting, the soil was covered with plastic, on which soil was heaped to prevent evaporation. After 2 and 4 days soil moisture samples were taken directly below the centre of the cylinder.

The dotted lines in Figure 1 represent the moisture content after 4 days, which can be considered as a rough estimate of field capacity, except for the Marl near Konya. In this profile the field capacity seems to decrease rapidly between 60 and 80 cm. It may be due to a lower permeability at a depth of more than 60 cm, so that the downwards movement of water is inhibited and the soil below 60 cm could not be moistened to field capapcity. The difference between field capacity and the moisture content in October (the end of the fallow year) is greater for the Terrace soils and the Marl near

Fig. 1. Average phase distribution and moisture content by volume throughout the profile down to 120 cm for TeB and TeC; BrA; LmA Konya and LmA Hotamış. Explanation in the text.



Şekil 1. TeB ve TeC; BrA; LmA Konya ve LmA Hotamış harita uniteleri için 120 cm ye kadar bütün profil boyunca ortalama faz dağılımı ve hacım olarak nem miktarı İzahı için yazıya bakınız.

Table 1. Assesments of average moisture in mm stored under fallow.

Layer	Soil Types			
	TeB + TeC (5 profiles)	BrA (6 profiles)	LmA Konya (4 profiles)	LmA Hotamış (4 profiles)
20–120 cm	55	75	90	45
120–200 cm	25	40	20	< 5
Total	80	115	110	45

Tablo 1. Nadas altında milimetre olarak biriktirilen tahmini ortalama nem miktarı.

Hotamış than for the reddish-brown Bajadas and the Marl near Konya, indicating that a greater part of the moisture capacity is used by the last two soils. The main causes of these differences are the lower rainfall on Terrace Soils and the Marl near Hotamış (compare Çumra and Karapınar in Figure 2 (these climatological stations are said to be the driest in Turkey) (Çumra, 1955–1965) and to the deep watertable in these areas (Part A, Fig. 66).

Relationship between moisture and dry-matter production.

The relationship between stored moisture and dry-matter production was estimated. The amount of stored moisture, transpired by crops has been calculated as the difference between stored moisture in October (sowing) and in the next July (harvest) in the layers from 20–200 cm. The decrease of the moisture content in the upper 20 cm was attributed to evaporation.

For dry-matter production, the grain and straw yields of the three highest yielding plots of each field trial (see Part A Chapter 7) have been averaged. As the moisture content of both straw and grain proved to be 6–7%, the weight of moisture is similar to the weight of dry matter in stubble and roots. Thus in the calculation of dry-matter production, both may be neglected. The highest yields have been chosen to ensure that moisture and no other factors (nitrogen or phosphate) were yield-limiting (Viets, 1962; Haise & Viets, 1957).

Figure 3 shows the relationship for 1967 and 1968. The regression lines were:

$P = 51.0\,S + 850$ in 1966–1967

and $P = 33.6\,S + 840$ in 1967–1968

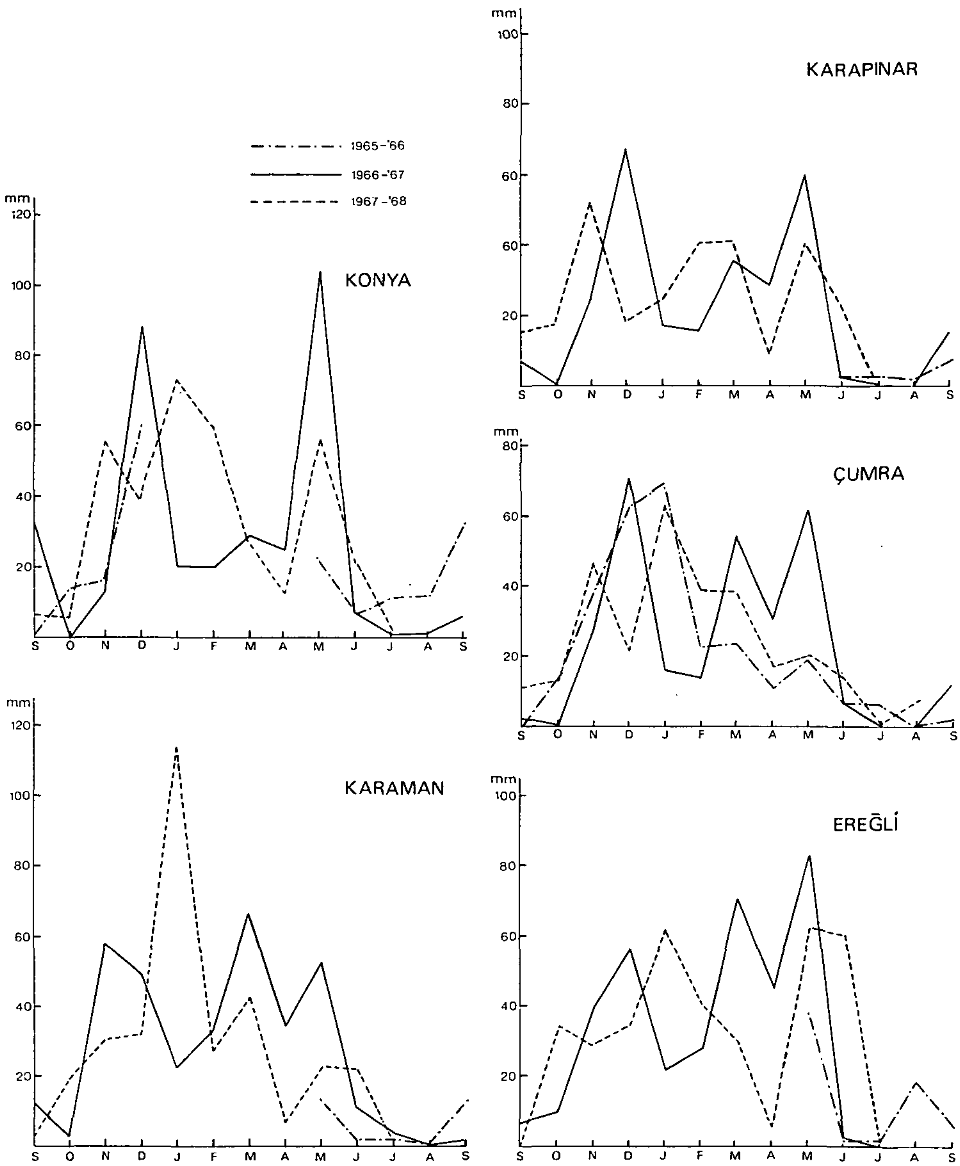
where P = yield of straw + grain in kg per ha

S = amount of stored water in mm

The curve for 1966–67 lies above the one for 1967–68. This means that in 1966–67 less stored water was needed for the same dry-matter production, because of the greater precipitation in 1966–67 (Fig. 2).

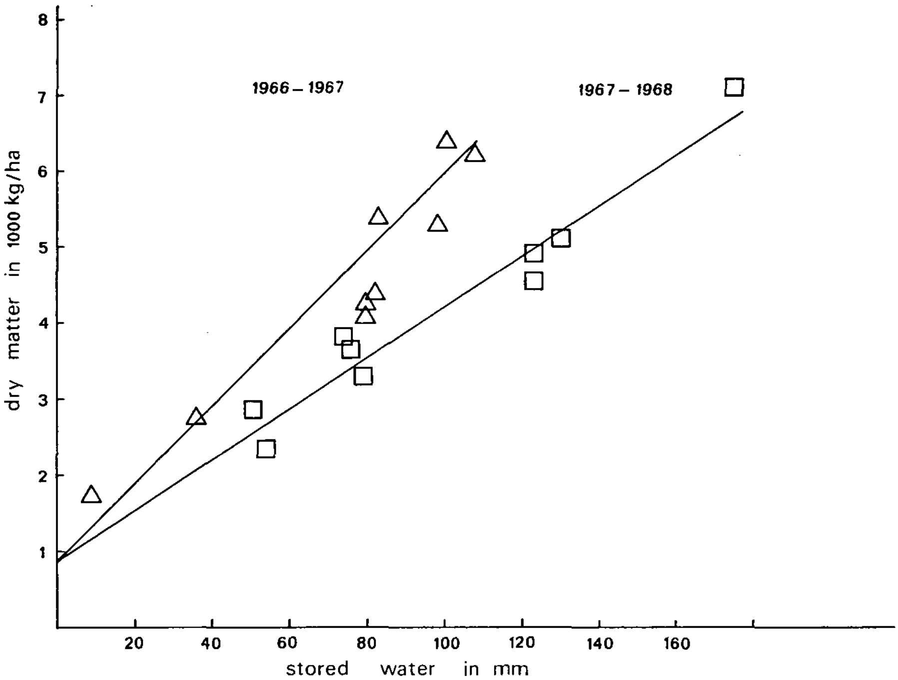
The fields with little stored moisture are also the fields with little rainfall (Fig. 1, Te and LmA Hotamış) and the difference in precipitation between 1966–67 and 1967–68

Fig. 2. Precipitation from September 1965 to July 1968 at 5 climatological stations.



Şekil 2. Eylül 1965'den Temmuz 1968'e kadar 5 iklim rasat merkezinde tesbit edilen yağış.

Fig. 3. Relationship between stored water and dry-matter production.



Şekil 3. Biriktirilen su miktarı ile kuru madde miktarı arasındaki ilgi.

is here smaller than at the other places where storage and rainfall are higher. Therefore the curve in 1966–67 is steeper than in 1967–68, and both curves cut the ordinate at the same height (840 kg/ha) (if there is no storage at all, precipitation is so low that differences in precipitation between the two years are negligible).

In May 1968 soil samples were taken in the wheat fields and on adjoining fallow spots (about 10 m apart on the same farmer's field). The difference in moisture content was assumed to have been transpired by plants, as shown below. The general equation for the water balance may be written in this way:

$$R + Sp \pm W + Irr = E + T + \Delta S + Dr \quad (1)$$

R	= rainfall	E	= evaporation
Sp	= seepage	T	= transpiration
W	= run-off	ΔS	= changes in water storage
Irr	= irrigation	Dr	= deep drainage

In the prevailing conditions seepage and run-off can be neglected, irrigation is absent, so that Equation 1 can be simplified to Equation 2.

$$R = E + T + \Delta S + Dr \quad (2)$$

The wheat and fallow fields are assumed to be equal in rainfall and in evaporation (and Dr) during winter, and there is no transpiration from the weedfree fallow. Hence

$$\Delta S_{fal} = \Delta S_{wh} + T \quad (3)$$

As the amount of water stored in October was the same for both fields, transpiration from October until May equals the difference in moisture content between the fallow and wheat fields in May. Hence

$$T = S_{fal} - S_{wh} \quad (4)$$

Fallow soil was not sampled in July so the estimate for that period in Table 2 was based on the sum of moisture loss from under the wheat and a third of the roughly estimated precipitation:

$$T = \Delta S_{wh} + R/3 \quad (5)$$

The data in Table 2 are, of course, very crude. Values until May are based on Equation 4 which contains many rough assumptions. Change in stored moisture from May to July can be rather accurately measured. The crudest component is the amount of rainfall utilized but luckily it is the smallest. For fields 101, 102 and 104 rainfall at Çumra was taken; for fields 103 and 108 that at Karapınar; for fields 106 and 107 that

Table 2. Components of transpiration from wheat fields from October 1967 to July 1968.

Field	Situation	Transpiration in mm				Dry matter in kg/ha
		Oct.-May[1]	May-July[2]		Oct.-July	
			ΔS_{wh}	R/3		
101	Okçu	13	90	8	111	2397
102	Türkmençamili	70	66	8	144	3922
103	Demiryali	29	65	14	108	2832
104	Inlikoy	90	51	8	149	3285
106	Tömek	83	60	17	160	4927
107	Zincirli	64	133	17	214	5129
108	Hotamiş	26	12	14	52	2363
114	Ilisera	28	132	12	172	4559
115	Suduraği	106	91	22	219	7123

1. Difference in moisture content in mid May of the layer 0–200 cm between fallow and wheat fields (S_{fal}–S_{wh}).
2. As fallow soil was not sampled in July, transpiration from mid May until July was assumed to be the sum of moisture loss from the layer 20–120 cm (ΔS_{wh}) and a third of precipitation (R/3), for which only a rough estimate was possible.

1. 0–200 cm lik toprak katında nadas ve ekili buğday tarlalarında ($S_{fal} - S_{wh}$) Mayıs ortalarında nem miktarları arasındaki değişiklik.
2. Kabaca tahmini mümkün olan, Nadas'lardan Temmuz ayında örnek alınmamış olması, Mayıs ortasından Temmuza kadar 20–120 cm lik toprak katından kaybedilen nem toplamı (ΔS_{wh}) yağışın üçte biri (R/3) olarak düşünülmek suretiyle hesap edilmiştir.

Tablo 2. Ekim 1967 den Temmuz 1968'e kadar buğday tarlalarından transpire edilensu.

of Konya; for Field 114 that of Karaman; and for Field 115 the average of Karaman and Ereĝli (Part A, Fig. 74).

The values in Table 2 for total transpiration and dry matter production yield the regression in Fig. 4, for which

$$P = 27.4T \quad (6)$$

where P is dry-matter production in kg per ha., and T is water transpired during the growth season in mm.

De Wit (1958) calculated for arid regions:

$$P = mT\,E_O^{-1}$$

where P and T are as in Equation 6, E_O is the evaporation from a free water surface in mm per day and m is a constant, being 115 kg per ha per day for wheat.

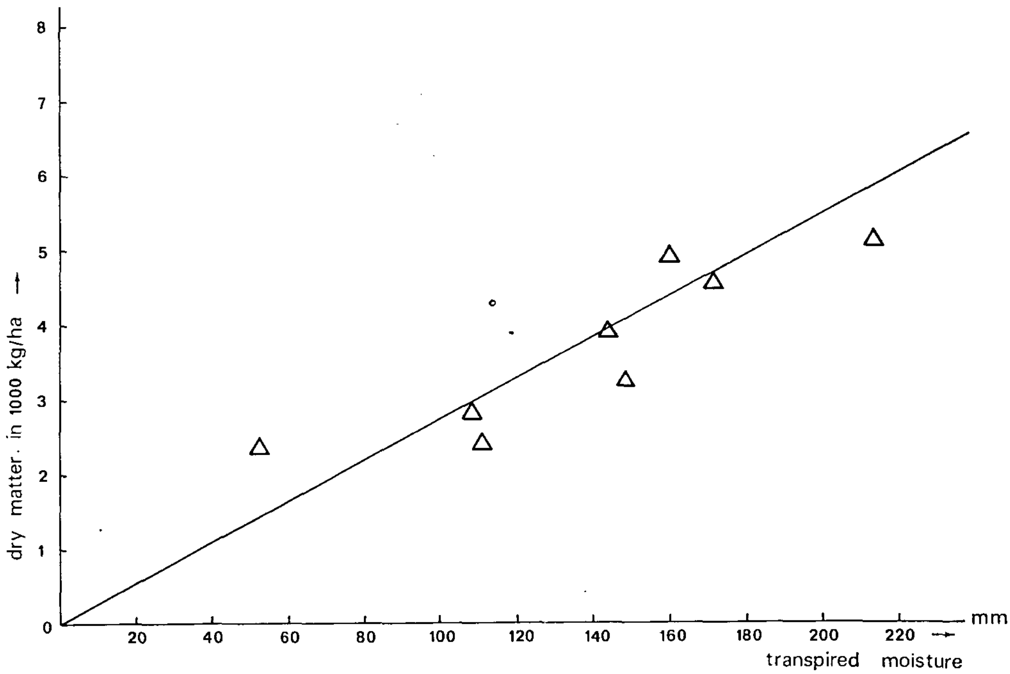
Substitution of $27.4T$ for P (Equation 6) gives:

$27.4\,T = 115\,T\,E_O^{-1}$ or $E_O = 4.2$ mm per day.

According to Kohler *et al.* (1955) E_O is 0.7 times pan evaporation, so an E_O of 4.2 mm means a pan evaporation of 6 mm. Some pan evaporation data for Konya and Çumra are given in Table 3.

The calculated pan evaporation of 6 mm per day or 180 mm per month seems a good average of pan evaporation from April to July 1968, which means that equation 6 satisfactorily describes the relationship between transpiration and dry matter pro-

Fig. 4. Relationship between transpired moisture and dry matter production.



Şekil 4. Sarfedilen su miktarı ile kuru madde miktarı arasındaki ilgi.

Table 3. Pan evaporation in mm per month at Konya and Çumra

	Jan.	Feb.	Mar.	Apr.	May	June	July
Konya 1967	28.8	15.7	42.7	77.3	–	124.1	153.1
Konya 1968	27.6	20.0	50.8	97.8	106.3	111.3	168.5
Çumra 1968	–	–	85.5	169.5	205.4	198.8	276.5

Tablo 3. Aylık mm olarak Konya ve Çumra'da pan evaporasyonu.

duction in 1968. The transpiration ratio or water requirement derived from Equation 6 is 365 kg water per kg dry matter, which is rather low.

For want of better possibilities Equation 6 is assumed to be valid also in 1966–67. Figure 5 shows the contribution to transpiration from rainfall and from stored water in the two years. In the first year the contribution of rainfall was higher.

The average dry-matter production was 5149 kg per ha in 1967 and 3998 kg per ha in 1968, the average effective precipitation was 96 and 51 mm, while the amount of water stored was nearly the same in both years (84 and 94 mm). The difference in effective precipitation seemed to be caused mainly by difference in rainfall in April and May. The averages for April and May of the 5 climatological stations are 105 and 51 mm for the respective years; for the whole seasons the figures were 305 and 315 mm (Fig. 2).

So the rainfall in April and May determines the yield above a certain minimum. This confirms long experience.

Yet water conservation was still important (44 and 64% of the transpired moisture) for total production of dry matter and especially for grain/straw-ratio, which was improved by an increase in available water. Therefore ways of increasing water conservation during fallow need study and development. Cleaning the arable land from weeds and ploughing the field at the right time (in early spring) are necessary measures. If more water is conserved, plants will be taller in spring and make more effective use of the rainfall.

Özet

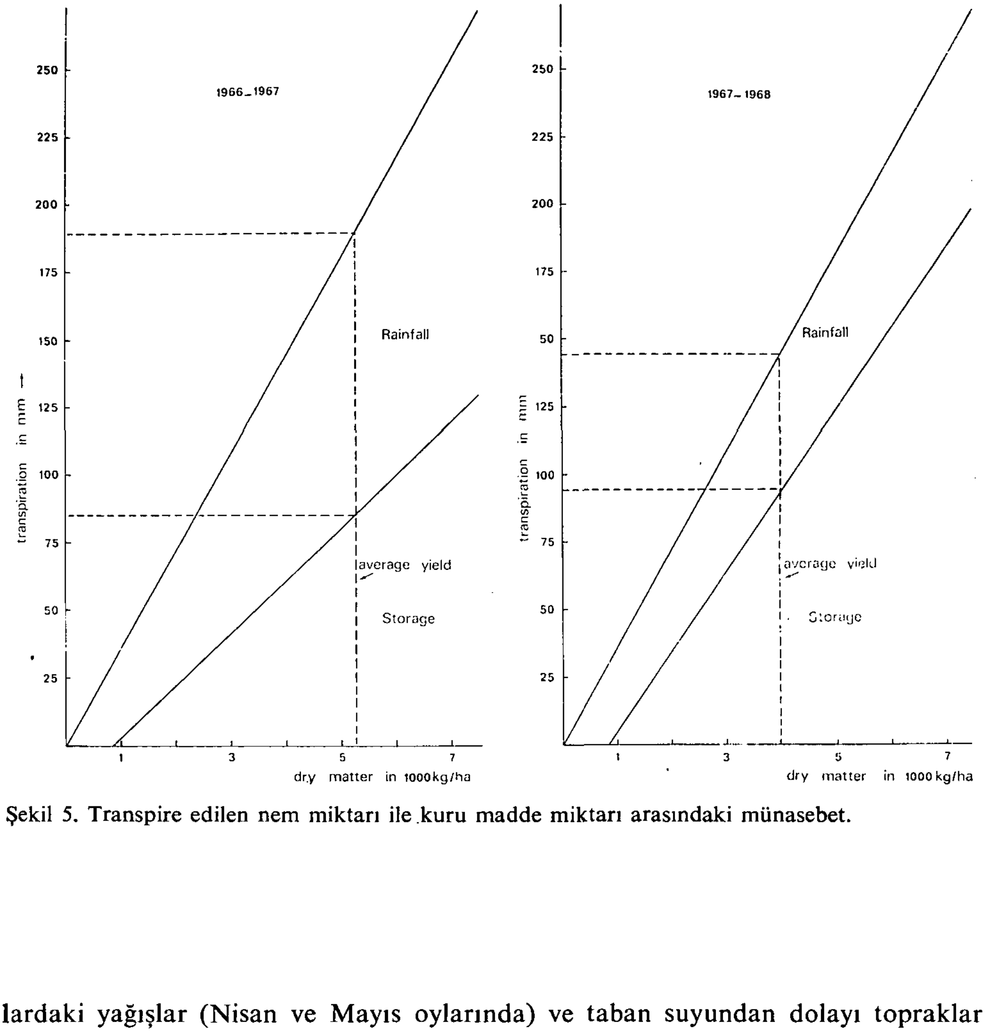
Büyük Konya havzasında kuru ziraatle buğday ve nadas sistemi en çok uygulanan çiftçilik şekli olarak nem muhafazası için kullanılmaktadır.

Toprak verimliliği çerçevesi içersine önemli toprak üniteleri üzerinde su muhafazası çalışmaları da dahil edilmiştir ve 1966, 1967 ve 1968 yıllarında ekilen ve nadas altında olan tarlalarda büyüme devresinin başında, ortasında ve sonunda toprak rutubetleri ve hacim ağırlıkları tesbit edilmiştir.

Elde edilen kayıtlardan muhafaza edilen nem ile kurumadde istihsali arasındaki münasebetler hesaplanmıştır.

Toprakların fiziksel özellikler indeki değişiklikler, aynı zamanda değişik miktar-

Fig. 5. Relationship between dry matter production and transpiration, as contributed by precipitation and water conservation.



Şekil 5. Transpire edilen nem miktarı ile kuru madde miktarı arasındaki münasebet.

lardaki yağışlar (Nisan ve Mayıs oylarında) ve taban suyundan dolayı topraklar arasında değişiklikler bulunmaktadır. Böylece nadas yılından dolayı su muhafazası, toplam kuru madde istihsalini ve özellikle tane/başak oranının elverişli su miktarının artmasıyla artırılmış olduğunun ehemmiyetini ileriye sürmektedir. Erken ilkbaharda yabani otlardan temizleme ve sürüm, su muhafazasının artırılmasında en önemli etkileyici ölçülerdir. Bundan başka, baharın bitkilere gelişme çağında (daha uzun olduğu sıralarda), yağmurun daha fazla etkileyici faydasının olduğu belirtilmelidir.

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Observations about the alkalinity in the Çumra Area, Great Konya Basin

C. G. E. M. van Beek & P. M. Driessen

Abstract

Soil salinity in the Great Konya Basin has already been discussed but little information has yet been given on alkalinity. Studies on soil alkalinity were concentrated in the Çumra area and as alkalinity is hard to trace in the field, all observations are based on chemical analysis. The ESP-SAR relation of samples with ECe between 8 and 16 mmho/cm appeared quite different from the well known nomogram in Handbook 60 of the US Department of Agriculture, evidently because of anion exclusion.

It was preferred therefore to estimate ESP from SAR according to its average relations in the saturation extract. Taking into account the possible errors, a soil alkalinity map of the Çumra Area with 3 classes was compiled. There were no non-saline alkali soils. Alkali soils occurred in the lower part (towards the centre of the Basin only, except for the Marls which were non-alkali). The Former Backswamp Soils were mainly medium alkali. The most alkali was found in strongly salt-affected soils, so the alkalinity map and the salinity map have a similar pattern.

Introduction

In the Konya Project attention was paid to salinization and alkalinization of the Çumra Area (Driessen & de Meester, 1969). Salinity has already been discussed (Part A. Chapter 6) but little information was given on alkalinity.

Alkalinization denotes any increase of sodium on the adsorption complex. Alkali soils are defined as soils with over 15% of their adsorption complex occupied by sodium.

Alkali soils may originate in different ways. In the Great Konya Basin they are usually formed by leaching of saline soils that are rich in sodium i.e. saline-alkali soils. Another way in which alkali soils may formed is by irrigation with sodium-rich irrigation water. For the Çumra Area this process is considered of little importance because of the low alkalinity hazard of Çarşamba irrigation water.

Methods of analysis

The CEC (cation-exchange capacity) and ESP (exchangeable sodium percentage) were estimated by methods of Handbook 60 (Diagnosis, 1954).

Basically the estimation of CEC comprises:

a. Replacement of all cations on the cation-exchange complex by Na^+, using an excess of sodium acetate;

b. Removal of all salts from the soil sample with 95% ethanol;

c. Replacement of Na^+ on the cation-exchange complex by NH_4^+ using an excess of ammonium acetate;

d. Estimation of Na^+ by flame-photometry.

If gypsum is present in the soil not all the cations on the cation-exchange complex are replaced by Na^+, because of contamination of the sodium acetate by Ca^{2+} from the gypsum. This Ca^{2+} occupies a relatively great part of the cation-exchange complex, so a too low concentration of Na^+ is measured and hence the CEC values are estimated too low. The error in CEC from the dissolving of gypsum is not known.

Basically the ESP is estimated from extractable and soluble Na^+.

Exchangeable Na^+ = extractable Na^+ — Na^+ in solution (in meq. per 100 g). Extractable sodium is estimated by flame-photometry of all the Na^+ from the soil solution and from the cation-exchange complex after expelling with an excess of ammonium acetate. Soluble sodium is estimated by flame-photometry in an extract of the saturated soil paste.

Even if the amounts of extractable and soluble Na^+ are correctly estimated, the value obtained for the amount of exchangeable Na^+ is not necessarily correct. This is illustrated by the following example of a saline alkali soil.

Soluble Na^+: ECe = 16 mmho/cm = about 0,2 *N*

SP = 100% (v/w)

ECe = electrical conductivity of saturated soil extract

SP = saturation percentage

This means that the soil solution contains approximately 20 meq salts per 100 g soil. If the soil solution contains about 50% sodium, then 10 meq Na^+ per 100 g is present (SAR = 14).

Exchangeable Na: SAR = 14. ESP = 16.

Assumed CEC = 20 meq per 100 g.

This means that the adsorption complex contains 3 meq Na^+ per 100 g. Extractable Na^+: 10 + 3 = 13 meq Na^+/100 g.

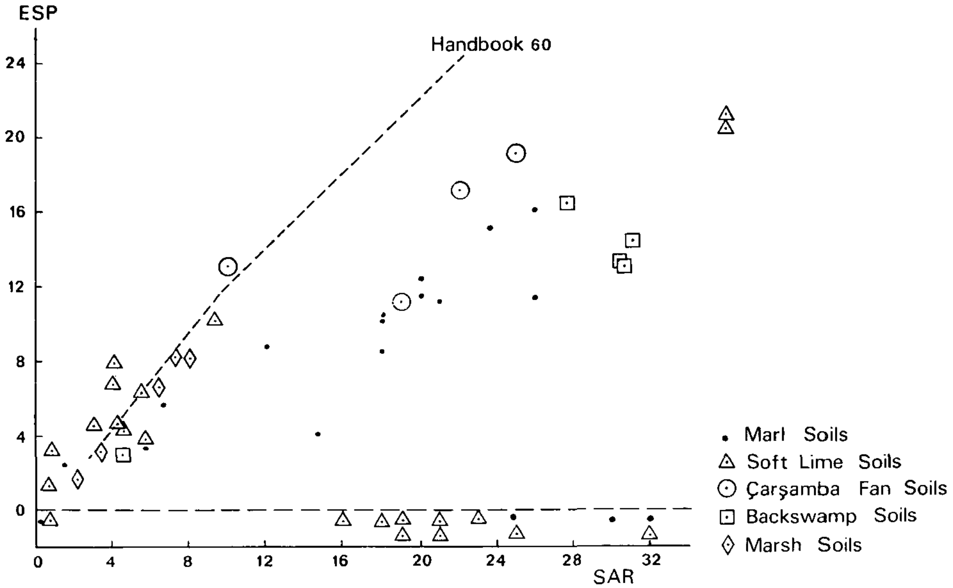
If extractable Na^+ and soluble Na^+ are high, and if they are substracted to give the amount of exchangeable Na^+, which is a small amount, the accuracy of the calculated value of exchangeable Na^+ is very doubtful. Allison (1964) agreed with this and used SAR value only.

Results and discussion

As soil alkalinity is hard to trace in the field many soil samples taken in the most important soils of the Çumra Area were brought to the Netherlands for chemical analysis. These samples were taken from the walls of newly dug profile pits or by augering to 120 cm.

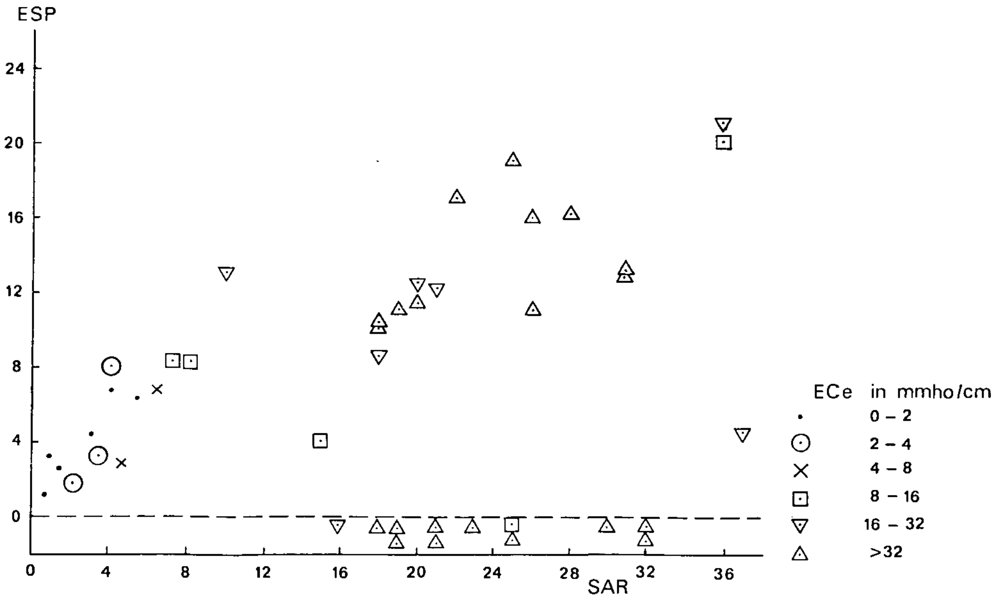
The results of analysis are shown in Figs. 1–2. In Fig. 1 values for ESP are plotted

Fig. 1. Relation between SAR and ESP in several soil associations.



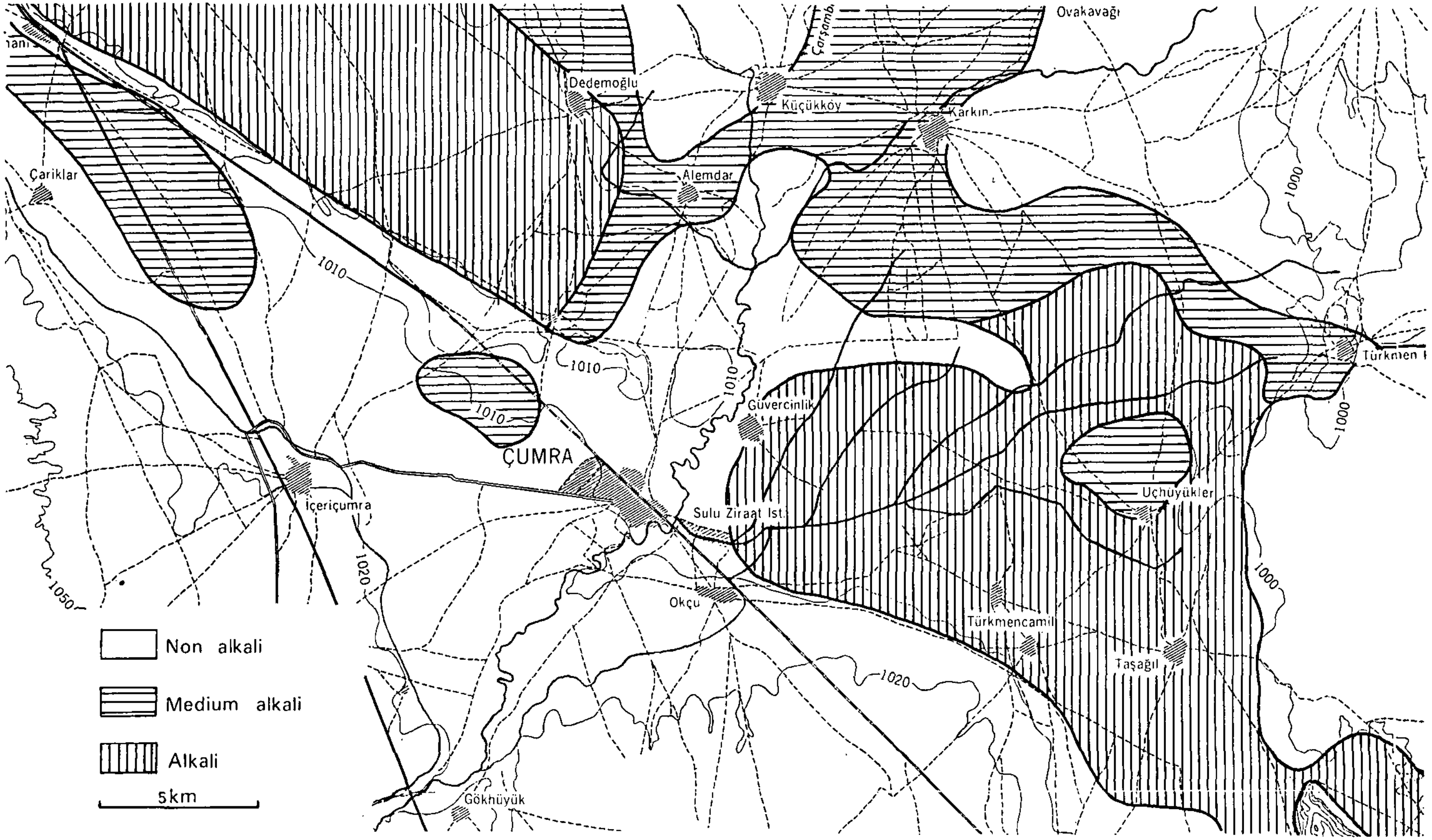
Şekil 1. Çeşitli toprak birliklerinde SAR ve ESP arasındaki ilgi.

Fig. 2. Relation between SAR, ESP and ECe for several salinity classes.



Şekil 2. Çeşitli tuzluluk sınıfları için SAR, ESP ve ECe arasındaki ilgi.

Fig. 3. Alikalinity sketch map for the soils of the Çumra Area.



Şekil 3. Çumra bölgesi için kabataslak alkalilik haritası.

against SAR, distinguished for each soil association. The relation between ESP and SAR according to Handbook 60 is also marked. Up to SAR values of about 10 the samples conform rather well to this relation but if SAR exceeds 10 the results obtained are too low. Surprising is the number of samples with a negative ESP. Bolt (pers. comm.) describes the feature of anion exclusion or negative adsorption. This is the repulsion of anions by the negatively charged surfaces of the clay minerals. It is possible to determine an 'effective' distance of repulsion. By multiplying this distance of repulsion by the specific surface of the clay mineral a saltfree volume is calculated. In the calculation of the amount of soluble salts too high a value is obtained because this value is calculated in relation to total water volume and not to total water volume minus saltfree volume. The anion exclusion relative to CEC increases with increasing concentration of the soil solution, with increasing amount of Na^+ on the complex and with decreasing surface charge density of the clay mineral.

In Fig. 2 ESP values are plotted against SAR but now the points are arranged in salinity classes. The points with an ECe of less than 8 agree rather well with the theoretical curve, but if ECe is between 8 and 16 the results obtained are too low. Bower & Hatcher (1962) found that the error in soluble Na^+ content became appreciable if ECe exceeded about 10 mmho/cm. To allow for errors in the determination of the soluble cations by the analysis of the saturation extract Bower & Goertzen (1955) suggested that Cl^- content of the soil should be measured in two ways:

a. By analysis of the saturation extract and

b. By analysis of the solution obtained by exhaustive leaching with water.

The soluble cation content determined by analysis of the saturation extract is then multiplied by the ratio (Cl^- content by leaching)/(Cl^- content by saturation extract). Some uncorrected data from Bower & Hatcher (1962) were even negative for exchangeable sodium as were some samples from the Çumra Area. Their corrected values of ESP are substantially higher than the uncorrected values and agree very well with the estimated value of ESP by conversion of SAR.

It is clear that the correction based on two different estimates of Cl^- cannot be complete, as the corrections for the saltfree volume introduced by other anions, in particular SO_4^{2-}, have also to be made. According to de Haan & Bolt (1963), it is possible to estimate the saltfree volume due to divalent ions from the saltfree volume due to monovalent anions. For this estimation the composition of the saturation extract has to be known.

Obviously negative values of ESP cannot be explained by the presence of the salftree volume.

The alkalinity map

Consideration of the possible errors involved in the direct measurement of ESP leads to the conclusion that this value can be estimated most reliably from its relation to the SAR of the saturation extract provided the cation exchange characteristics of the soils are known. Allison (1964) prefers also working with the SAR, because it takes into consideration changes both in concentration and composition of the salts present.

Fig. 3 is an alkalinity sketch map of the soils of the Çumra Area. ESP values were not available for this map. So it was based upon SAR values, compiled from data of DSİ (Devlet Su İşleri) and from Project data. Due to this variety of sources a somewhat modified classification was used:

SAR: < 5: non-alkali, throughout the profile (0–120 cm);
5–20: medium alkali, dominant in the profile;
> 20: alkali, dominant in the profile;

Only the lower parts of the area are alkali except for the Marl Soils and part of the Backswamp Soils of the River Çarşamba. Thus the Soft Lime Soils, the Sandplains Soils and the eastern part of the Alluvial Plain Soils of the Çarşamba are alkali (*cf.* Part A, Chapter 5).

Most of the Çarşamba Backswamp Soils are medium alkali. The higher parts of the area are non-alkali, they are the Bajada Soils, the Terrace Soils, the May Fan Soils, the Alluvial Plain Soils of the Çarşamba and the elongated Sandridge Soils; however part of the Backswamp Soils and the Marl Soils are non-alkali too.

Probably the distribution of alkali soils corresponds with the drainage condition and the occurrence of seepage or floods, either by surface run-off or by irrigation. So the higher parts with good drainage are non-alkali. Those lower parts collecting surface run-off water, or seepage or that are poorly drained with inadequate irrigation are alkali, while the rest is non-alkali. As a rule the highest SAR values occur in strongly salt-affected areas, so the alkalinity sketch map shows a pattern comparable to that of the salinity map.

Özet

Büyük Konya havzasında toprak tuzluluğu kısım A'da münakaşa edilmiş ve burada alkalilik hakkında kısa bilgi verilmişti. Alkalilik hakkındaki çalışmalar Çumra havalisinde yoğunlaştırılmış laboratuvar analizlerine dayandırlmıştır. ECe'leri 8–16 mhos/cm arasında olan örneklerle ESP ve SAR arasındaki münasebetler elkitabı 60 taki nomogramdan, belliki anyonların hariçte tutulmasından (anion exclusion) dolayı, oldukça farklı görüldü. Bunun için doygunluk ekstraktında ortalama oranlara göre ESP'nin SAR dan tayini tercih edilmiştir. Mümkün hataları göz önüne alarak Çumra bölgesinin 3 sınıf içersinde toprak alkalilik haritası yapılmıştır. Alkali olmayan marnlar hariç olmak üzere, alkalilik yalnız alçak sahalarda (yani havzanın ortalarına doğru) bulunmuştur. Genellikle önceki bataklık ardı toprakları orta alkalidir. En yüksek alkalilik, çok fazla tuz etkisinde kalan topraklarda bulunmuştur, böylece alkalilik haritası ile tuzluluk haritası hemen hemen aynı desenleri göstermektedirler.

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Infiltration experiments on soils of the Great Konya Basin

W. L. Peters

Abstract

Mixed soil samples from 6 profiles of the mapping units LmE, TeA, LmA, LmD. TeA and LmA (salt-affected) were used for infiltration and percolation experiments, The cylinders used were of plastic and soil segments could be analysed separately. The following experiments were carried out:

1. Percolation of flooded soil from below. The speed of infiltration and percolation were measured. The percolated water was collected and analysed. Soils 4 and 6 collapsed entirely.
2. Percolation without excess water. When moisture percolated to the bottom of the column the soil column was dried. The results show that irrigation with a limited supply of water causes sufficient downward movement of salts, but with too little water, salt may accumulate near the surface.
3. Infiltration from the bottom towards the surface.

The experiments showed that soil suitability for irrigation could be tested with a simple apparatus in the laboratory, but the natural profile may be entirely different in structure, stratification and porosity from the mixed samples.

Introduction

Because of the importance of irrigation in the Basin, the effect of percolation of water of the same composition as in the Çarşamba irrigation water was studied in 6 soils (Table 1).

According to the criteria of the US Department of Agriculture's Handbook 60, Profiles 1, 4, 5 and 6 were saline-alkali soils, Profile 2 was saline non-alkali and Profile 3 was neither saline nor alkali. The water was category C_2S_1 (fair quality). Its composition is given in Table 2. Several of the studied profiles are described in Part A, Chapter 5, viz Soil 1 is from Profile 42, Soil 2 from Profile 3 and Soil 5 from Profile 10.

Soil profile data

The experiments were on mixtures of soil samples, taken from 5 different profiles at regular intervals to a depth of 120 cm. Such a mixture may combine the various chemical and some physical properties of the profile, but many other important soil conditions, such as soil structure and stratification are destroyed.

Table 1. Analytical data for the soil samples from the six profiles.

Sample No	Soil unit	Saturation %	(SAR) Na-adsorption ratio	In the saturation extract									% moisture (airdry)
				EC Wheatstone bridge	pH	Ca + Mg in meq/l	Na in meq/l	K in meq/l	Cl in meq/l	SO_4 in meq/l	CO_3 in meq/l	HCO_3 in meq/l	
1	LmF	54.2	59	52.4	8.14	198.6	590	20.5	377	439.8	—	2.13	7.4
2	TeA	71.9	10	9.4	7.85	68.7	57	0.01	27.9	87.6	—	3.27	4.8
3	LmA	55.3	2.1	1.2	7.70	9.4	4.5	0.36	3.03	5.05	—	4.07	3.5
4	LmD	68.8	1200	82	9.65	4.16	1680	8	1296	225	103	19.9	4.1
5	TcA	40.6	46	24.4	7.75	44.8	212	15.5	151	113	—	6.7	2.2
6	LmA	40.6	480	24.8	9.35	4.78	720	2.86	140	653.5	16.1	9.3	3.6

Tablo 1. Altı toprak profilinden alınan toprak örneklerine ait analitik bilgiler. Analizler kullanılan metodlara göredir (Teşhisler 1954).

Table 2. Analytical data of the water used for irrigation (River Çarşamba May 1965)

SAR value	EC_{ir} in mmho/cm	pH	Ca + Mg in meq/l	Na in meq/l	Cl in meq/l	SO_4 in meq/l	HCO_3 in meq/l
0.2	0.320	7.80	2.90	0.27	0.2	0.9	2.07

Tablo 2. Sulama için kullanılan suya ait analitik bilgiler (Çarşamba Çayı, Mayıs 1965).

Soil 1 Map unit LmE, location: Çumra Area; physiography: recently dried marsh; topography: flat; land-use: range; parent material: highly calcareous silt loam and silty clay; watertable 150 cm.

The profile has subangular-blocky structure in the upper 41 cm and then becomes angular-blocky or prismatic. There is a calcic horizon between 57–90 cm and gypsic veins and crystal clusters are abundant below 57 cm. The profile is classified according to the USDA 7th approximation ('64) as an Aquic Calciorthid.

Soil 2 Map unit: TeA; location: Çumra Area; physiography: structural terrace; topography: flat, nearly level; land-use: dry cultivation of wheat; parent material: calcareous clay-loam; watertable deeper than 10 m.

The profile has a subangular-blocky structure down to 140 cm. There is a calcic horizon with many distinct calcareous concretions between 50 and 100 cm. The profile is classified as a Mollic Calciorthid.

Soil 3 Map unit LmA; location: Hotamış area; physiography: lacustrine plain; topography: flat and level; land-use: range land; parent material: carbonatic clay (marl); watertable: below 10 m.

The profile has a weak fine subangular structure in the upper 50 cm becoming strong angular and compound prismatic with increasing depth. The soil colour is predominantly light-olive-gray (5Y 6/2). The subsoil contains secondary carbonates, many shell fragments and yellow rust mottles. The profile is classified as a Typic Calciorthid.

Soil 4 Map unit LmD, location Karapınar Area East; physiography: saline depression or playa; topography: flat; land-use: no; parent material: carbonatic clay (marl); watertable: 2 m.

The profile has a strong coarse prismatic structure in the upper 50 cm and is strong medium angular-blocky below. Its colour is light-olive-gray (SY 6/2) and at the surface deep cracks occur in the dry season. The profile is classified as Aquic salorthid.

Soil 5 Map unit TcA; location: Çumra Area; physiography: structural terrace, flattened by abrasion; topography: flat; parent material: soft (unconsolidated) calcium carbonate; land-use: poor range land; watertable: 160 cm.

The profile has a shallow loamy surface soil with weak subangular structure. The carbonate subsoil is angular-blocky or platy. The subsoil has many mesopores and macropores and below 100 cm common rust mottles and calcareous concretions. The profile is classified as a Rendaquollic Haplorthent.

Soil 6 Map unit LmA (salt-affected phase); location: Karapınar Area East; physiography: lacustrine plain; topography: flat, nearly level; parent material: carbonatic clay (marl); land-use: ranging; watertable: deeper than 3 m.

The profile has a weak subangular-blocky surface soil and the subsoil consists of granular pseudosand with weak coarse prisms as secondary elements. The profile is classified as a Salorthid.

Percolation of flooded soil drained from below

For percolation experiments sieved soil was packed in plastic cylinders 30 cm high and 5.9 cm diameter (Fig. 1). Depth of infiltration was noted at intervals and when the whole was soaked, percolated water was collected from the bottom into a sample changer. Sampling was continued until EC (electrical conductivity) of the filtrate fell below 4.

With this system, ion concentrations in the soil solution are highest at the bottom of the columns and it can be assumed that the whole column has an EC less than that in percolated water. The outflow of water to reduce the ion concentration in the column to this value was noted. Water supply from the siphon was kept slow so that percolating water could approach ionic equilibrium with the soil.

In soil 1 water percolated 22.5 cm in 43 h. Composition is given in Table 3. EC fell below 4 when 25.9 cm of water had passed through the column. The column contained 924 g soil which required, at a saturation percentage (SP) of 54.2 %, 924 × 54.2/100 g water. Thus about 500 cm^3 water or a column of 500/5.9 = 19 cm water were needed.

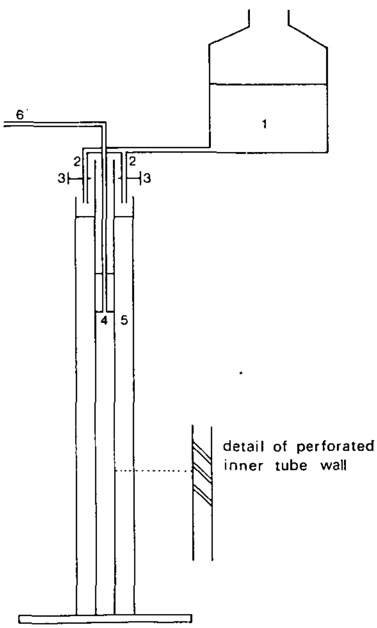


Fig. 1. Apparatus for flood-irrigation of soils.

1. Bottle of irrigation water
2. Droppers
3. Clips to control flow
4. Inner tube (diam. 2.5 cm) with plunger
5. Other graduated tube (diam. 5.2 cm) with sample
   Outer tube is marked in 25 segments of 3.8 cm.
6. Connection to vacuum pump.

1. Sulama suyu şişesi
2. Damlalıklar
3. Akış kontrol eden kışkaçlar
4. İçten tüplü (2.5 cm çapında) itici
5. Örnekleri ihtiva eden dereceli tüpün dışı (5.2 cm çapında) dıştan 3.8 cm lik 25 parçalı olarak işaretli tüp
6. Vacum pompasına bağlantı

Şekil 1. Topraklara salma-sulama yapabilen alet.

Table 3. Composition of the filtrate from the column of Soil 1

Percolated water in cm	EC in mmho/cm	Ca + Mg in meq/l	SO_4 in meq l	Cl in meq/l	Na in meq/l	SAR value
0.4	160	2038	2167	3716	4000	126
1.5	150	913	1906	2063	2840	130
2.0	116	462	1360	739	1860	122
3.0	90	343	1100	660	1440	109
4.5	68	268	858	380	980	85
6.3	44.4	162	575	142	530	59
7.9	28.0	88.4	364	46.6	303	50
9.6	20.0	58.4	242	19.0	190	35
11.3	14.0	45.0	173	7.05	125	26
12.5	11.6	40.5	139	3.90	81	18
14.3	9.2	37.4	110	2.06	67	15.5
15.6	7.6	35.3	86.7	1.18	48	11.5
17.2	6.8	34.9	76.6	0.94	35.3	8.5
18.8	5.8	37.2	66.2	0.57	26.0	6.0
20.5	4.9	35.9	55.0	0.58	18.0	4.25
22.4	4.62	37.8	51.8	0.56	12.4	2.85
23.8	4.26	38.4	48.7	0.43	8.4	1.92
25.4	4.04	38.9	47.4	—	5.4	1.21
27.2	3.92	39.5	45.3	—	4.8	1.08

Tablo 3. 1 Numaralı toprak kolonundan elde edilen süzüğün bileşimi.

Table 4. Composition of the filtrate from column of Soil 2

Percolated cm water	EC mmho/cm	$Ca^{2+} + Mg^{2+}$ meq/l	SO_4^{2-} meq/l	Cl^- meq/l	Na^+ meq/l	SAR
0.4	64	500	316	551	455	29.0
1.5	41.4	314	282	287	300	24.0
3.0	26	185	276	88.4	199	20.8
4.0	17.6	108	242	12.2	136	18.4
4.7	13.6	90	195	4.10	104	15.5
5.9	12.0	77	172	2.11	91	14.7
6.5	10.8	70	150	1.40	76	12.8
7.2	9.8	68	134	1.00	69	11.8
8.6	8.2	63	115	0.82	52	9.5
10.0	6.8	57	92.2	0.54	38.7	7.2
11.9	5.6	55	76.0	0.43	24.5	4.6
12.9	4.9	55	68.5	0.41	15.4	2.9

Tablo 4. 2 Numaralı toprak kolonundan elde edilen süzüğün bileşimi.

Sodium-adsorption ratio (SAR) and EC decreased regularly during percolation but noteworthy is the high final concentration of sulphate.

Although conditions of percolation are more ideal than in the field, the data can indicate how much water is needed to desalinize 1 cm^2 of soil to a certain depth, for example 50 cm. For 1 cm^2 surface there is 80 g soil to 50 cm depth. This requires 54 cm for desalination, plus 43 cm to soak the soil. Thus per hectare this is 97×10^8 cm^3 water or 97×10^5 litres.

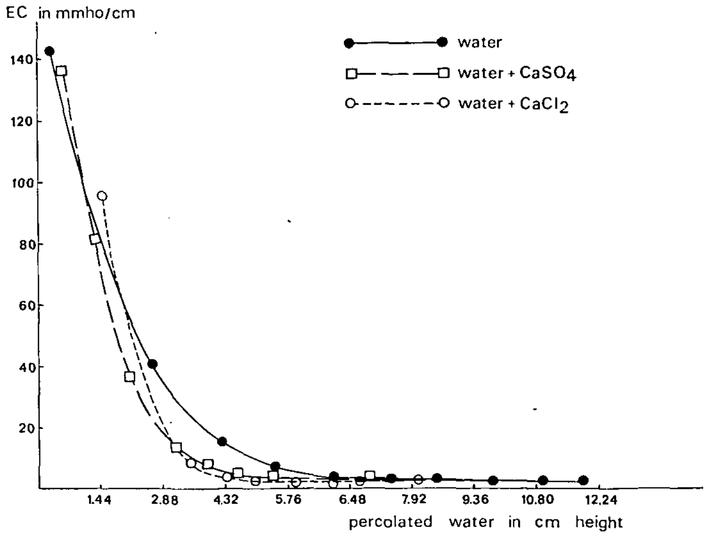
For soil 2 (Table 4) outflow was 13 cm and 20 cm was needed to soak the soil, 33 cm

Table 5. Composition of filtrate from column of Soil 3

Percolated cm water	EC mmho/cm	$Ca^{2+} + Mg^{2+}$ meq/l	SO_4^{2-} meq/l	Cl^- meq/l	Na^+ meq/l	SAR
0.5	8	83	29.3	34.4	16.3	2.50
1.5	4.8	51	23.8	15.6	11.9	2.35
2.4	3.30	32.4	21.7	6.45	9.3	2.30
3.8	2.12	18.7	16.7	1.96	6.9	2.25
4.7	1.52	11.4	11.4	0.55	5.7	2.30
6.1	1.32	9.4	8.2	0.53	4.7	2.17

Tablo 5. 3 Numaralı toprak kolonundan elde edilen süzüğün bileşimi.

Fig. 2. Change in EC in relation to amount or percolated water for columns of Soil 5 without treatment or with added calcium sulphate or calcium chloride.



Şekil 2. EC'nin değişmesiyle, muamelesiz veya kalsiyum sülfat veya kalsiyum klörürle muamele edilmiş 5 numaralı toprak kolonunda elde edilen süzük miktarı arasındaki ilgi.

in all. Moisture reached 24 cm in 140 minutes.

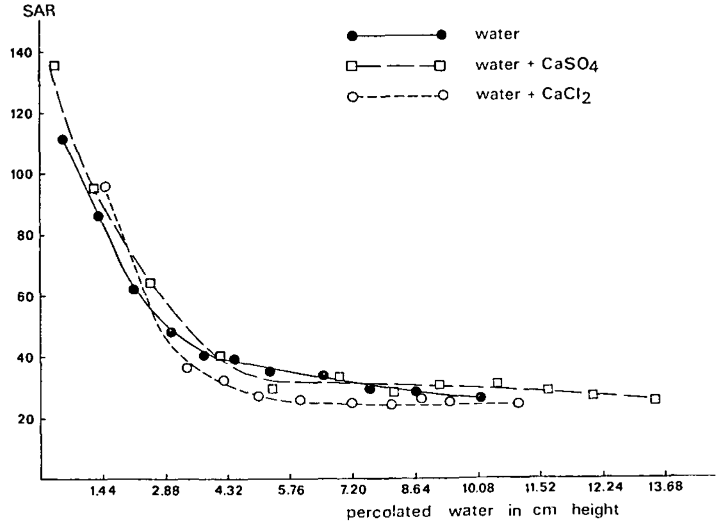
Soil 3 (Table 5) did not need desalination; percolation to 24.2 cm took 400 min. Soils 4 and 6 were only slowly percolated, moisture reaching only 14 and 8 cm after 112 h. Saturation extracts of soil 4 contained more salt (total ions) than soil 6, so that

Table 6. Composition of filtrate from column of Soil 5.

Percolated cm water	EC mmho/cm	$Ca^{2+} + Mg^{2+}$ meq/l	SO_4^{2+} meq/l	Cl^- meq/l	Na^+ meq/l	SAR
1.1	136	599	575	1522	1930	111
1.6	82	238	448	618	945	87
2.8	37	75	245	197	380	62
3.3	14.8	17.8	104	42.4	144	48
4.2	7.6	6.4	69.6	12.3	72.5	40
4.7	4.7	2.96	29.4	4.98	46.5	38
5.9	3.41	2.14	19.2	1.78	36.8	35
7.1	3.22	1.80	15.4	1.16	32.5	34
8.2	2.60	1.48	8.48	0.86	25.0	29
9.0	2.40	1.39	7.36	0.77	23.8	28
11.4	2.21	1.35	6.88	0.77	20.7	25

Tablo 6. 5 Numaralı toprak kolonundan elde edilen süzüğün bileşimi.

Fig. 3. Change in SAR in relation to amount of percolated water for columns of Soil 5 without treatment or with added calcium sulphate or calcium chloride.



Şekil 3. SAR'ın değişmesiyle, muamelesiz veya kalsiyum sülfat veya kalsiyum klörürle muamele edilmiş 5 numaralı toprak kolonunda elde edilen süzük miktarı arasındaki ilgi.

under irrigation it would remain longer flocculated. Because of the predominance of Na^+ over $Ca^{2+} + Mg^{2+}$, the structure of both soils would completely collapse with prolonged irrigation. Irrigation of such soils would be useless.

For soil 5 (Table 6) percolation to 23.5 cm took 43 h; the column soaked up 12 cm of water. With an outflow of 11.4 cm water, thus input 23 cm, EC dropped to 2.2 but sodium-adsorption ratio remained 25, showing that the material had changed to a non-saline alkali soil. With the amount of divalent cations in the water used, exchange and release of Na^+ would have been slow. To speed up the process, calcium sulphate and calcium chloride were added at the upper end of two columns but the rate of removal of sodium, as shown by changes in EC (Fig. 2) and sodium-adsorption ratio (Fig. 3), were not affected. Presumably the calcium ions were eluted before they could exchange to significant extent with adsorbed sodium.

Percolation without excess water

Samples were placed in the apparatus shown in Fig. 4. After moisture had reached a certain point near the bottom of the sample, it was dried with the vacuum pump. The procedure was repeated five times and required 118 g water in all for soil 2. Afterwards 1 : 4 extracts of segments of 3.8 cm were analysed (Table 7). The results show that irrigation with a limited supply of water causes a downward movement of salts but if too little water is used they may accumulate not far from the surface.

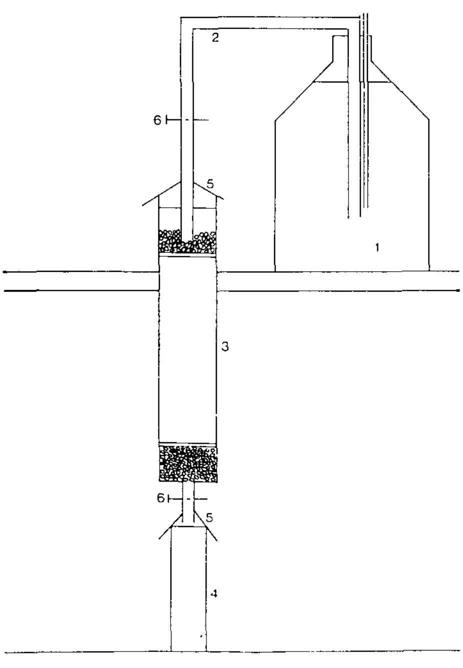


Fig. 4. Apparatus for irrigating soils without flooding.

1. Bottle of irrigation water
2. Siphon
3. Cylinder 30 cm long containing soil sample
4. Measuring cylinder to collect percolated water
5. Evaporation seals
6. Clips to control flow.

1. Sulama suyu şişesi
2. Sifon
3. Toprak örneği ihtiva eden 30 cm uzunluğunda silindir
4. Sızan suyu toplayan ölçü silindiri
5. Evaporasyon koryuucuları
6. Akış kontrol eden kıskaçlar

Şekil 4. Salma yapmaksızın toprakları sulayan alet.

Table 7. Effect of repeated sprinkling irrigation and drying on distribution of various ions in Soil 2.

Segment No	EC_4 (mmho/cm)	Ca + Mg	Cl (meq/liter)	SO_4	Na	SAR
1 (top)	0.40	3.62	0.14	2.94	0.22	0.16
2	0.78	8.90	0.14	7.62	0.22	0.10
3	1.12	13.6	0.14	13.6	0.22	0.08
4	1.53	17.4	0.14	17.4	0.22	0.07
5	1.72	20.9	0.14	21.5	0.22	0.07
6	1.92	25.4	0.14	25.2	0.22	0.06
7	2.16	28.3	0.14	29.2	0.24	0.06
8	2.68	36.5	0.14	38.7	0.26	0.06
9	3.22	47.2	0.18	49.0	0.48	0.10
10	3.16	46.5	0.16	47.5	0.60	0.12
11	3.12	45.6	0.18	47.8	0.60	0.13
12	3.40	51.0	0.20	51.9	0.64	0.13
13	3.50	53.2	0.20	54.2	0.64	0.12
14	3.48	52.6	0.21	53.7	0.68	0.13
15	3.58	54.2	0.21	55.1	0.68	0.13
16	3.86	61.1	0.21	62.0	0.80	0.14
17	3.64	57.6	0.21	57.1	0.88	0.16
18	3.82	59.8	0.21	60.9	1.04	0.19
19	4.00	63.8	0.31	65.4	1.24	0.22
20	4.32	70.3	0.35	71.0	1.84	0.31
21	4.20	63.0	0.35	62.1	2.96	0.53
22	4.94	75.4	0.53	79.3	5.8	0.94
23	8.40	84.9	8.3	118	44	6.8
24	19.60	143	74.4	222	165	19.5
25 (bottom)	8.80	85.2	34.0	84	40	6.1

Tablo 7. Tekerrürlü yağmurlama sulama ve kurumanın iyon dağılımı üzerine olan etkisi.

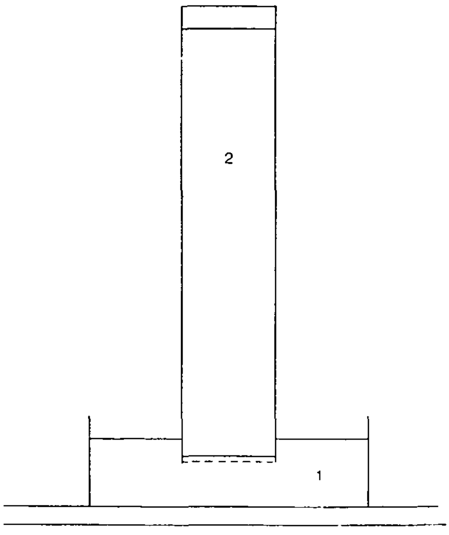


Fig. 5. Apparatus for infiltrating soil from the bottom of the column.

1. Trough of irrigation water.
2. Graduated tube with porous base-plate containing soil sample.

Şekil 5. Kolonun altından suyun toprağa girmesini sağlayan alet

1. Sulama suyu ile.
2. Dereceli tüp ile toprak örneği ihtiva eden poröz temel-levha.

Table 8. Effect of water percolating from bottom to top of column on distribution of various ions in Soil 2.

Segment No	EC_4 (mmho/cm)	Ca + Mg	SO_4 (meq/liter)	Na	Cl	SAR	Moisture %
1 (top)	5.12	58.5	61.3	11.5	6.4	2.13	23.6
2	13.2	113	76.3	47.0	68.0	6.3	30.9
3	10.8	88.9	74.0	43.0	46.9	6.5	35.6
4	7.6	63.9	72.0	38.0	16.7	6.7	39.4
5	6.4	56.8	78.6	28.8	4.63	5.4	41.6
6	5.62	48.9	72.4	26	3.20	5.3	42.5
7	5.18	49.4	68.5	21.5	0.64	4.3	43.1
8	5.02	53.2	68.6	17.3	0.36	3.4	43.7
9	4.42	47.5	58.8	14.0	0.27	2.84	45.6
10	4.42	51.8	61.1	11.3	0.29	2.22	46.4
11	3.92	47.4	53.2	7.3	0.36	1.56	47.5
12	3.72	49.8	50.9	3.68	0.31	0.74	48.4
13	3.56	49.2	50.5	1.76	0.33	0.35	48.4
14	3.44	49.3	47.3	1.0	0.31	0.20	49.6
15	3.60	47.8	50.9	0.70	0.29	0.14	49.6
16	3.32	48.6	45.8	0.40	0.25	0.08	48.6
17	3.32	48.3	46.3	0.50	0.29	0.10	50.1
18	3.12	46.8	42.5	0.45	0.27	0.09	53.2
19	2.96	41.4	50.4	0.32	0.33	0.07	48.2
20	1.62	19.0	18.6	0.30	0.33	0.09	53.0

Tablo 8. 2 Numaralı toprakta kolonun altından üstüne doğru emilen suyun çeşitli iyonların dağılımı üzerine olan etkisi.

Infiltration from the bottom towards the surface

A sample of soil 2 was placed in a column 100 cm high and 5.9 cm diameter with a permeable base standing in a trough of water (Fig. 5). After the moisture had reached the upper surface, 5 cm segments of the soil column were analysed (Table 8). With a net moisture gradient from below to the surface, as when soil is irrigated by percolation, this type of soil forms a saline surface layer.

Conclusions

The following conclusions can be drawn:

1. The suitability of a soil for irrigation can be tested in the laboratory with a simple apparatus.
2. Laboratory experiments can indicate the amount of water needed to leach salt from the soil to an arbitrary final content. It should be noticed, however, that in these experiments differences in the physical properties of the soil have not been taken into account. The results apply in practice only to homogeneous soils.
3. Laboratory experiments can show any eventual specific behaviour of the soil upon irrigation. In particular this is of importance in saline-alkali soils.

Özet

LmE, TeA, LmA, LmD, TeA ve LmA (tuzlu) harita ünitelerinden 6 profilin karıştırılmış örnekleri infilitrasyon ve sızma (percolation) denemeleri için kullanılmıştır. Bunun için plâstik parçalar halinde yapılmış, istenildiğinde tek tek analiz edilebilen toprak silindirinden faydalanılmıştır.

Aşağıdaki deneyler bu amaca hizmet için yapılmıştır.

1. Üzerine su taşırılan toprağın alttan sızdırması: İnfilitrasyon ve sızma hızı ölçülmüştür. Süzük toplanmış ve analiz edilmiştir. 4 ve 6 numaralı topraklar tamamen açılmıştır.
2. Aşırı su olmadan perkolasyon: Nemin kolonda tabana erdiği anda toprak kolonu kurutulmuştur. Sonuç sulama suyunun sınırlı bir şekilde tatbiki, yeterli miktarda tuzun aşağıya hareket ettiğini göstermektedir. Fakat az miktarda tuzun yüzeyde birikmesi vuku bulabilir.
3. Tabandan kolonun yüzeyine doğru inflitrasyon.

Deneyler toprakların sulama suyuna olan uygunluklarının laboratuvarda basit aletlerle elde edilmesinin mümkün olduğunu göstermektedir, fakat strüktür, tabakalaşma ve porozite gibi toprakların tabii durumlarının, karıştırılmış örneklerde aslından tamamen değişik olabileceğinin bilinmesi gereklidir.

The preparation of soil peels in arid regions[1]

T. de Meester

Abstract

Soil profile peels, combined with a field description, are of great value for the study of soil morphology, for soil classification and for instruction. As a result of experience, gained in the Great Konya Basin successful field methods were described for:

a. The preparation of soils peels of dry calcareous soils, in particular clayey soils.

b. The preparation of soil peels from vertical walls instead of from sloping ones, especially with dry soils.

Advice is given on how to carry completed soil peels without damage. As illustration the production cost was calculated of one soil profile peel in Turkey. Estimates were based on maximum use of local labour and materials.

Introduction

A detailed profile description, however well made, can never fully reproduce the described profile, even with illustrations. So techniques for preserving undisturbed soil profiles are of great importance for demonstration, education and research. Adequate profiles need to be at least 30 cm (1 ft.) wide and 100–150 cm (3–5 ft) deep. The preserved profiles have been called pedon-tracts, monoliths and soil profile peels. The last name is most accepted and is here abbreviated peel.

Many authors have described peeling techniques for moist (including slightly moist) and wet soils. For the dry hard calcareous soils commonly encountered in arid regions the literature provided little information on how to surmount special problems. During three prolonged visits to the Great Konya Basin we developed successful technique-for making soil peels, of which about 60 were prepared. All profile photographs in Chapter 4 of Part A were made from them.

Common procedure

Stage 1: The section is evened off to obtain a favourable face for application of lacquer.

Stage 2: The lacquer or resin is applied to the profile face, which it penetrates and

1. Abbreviated from a paper in Neth. J. agric. Sci. 15 (1967); 63–74.

impregnates. After gradual hardening the constituents of the soil material are fixed in natural arrangement.

Stage 3: The impregnated section, the soil peel, is gently separated from the loose soil mass.

Stage 4: The peel is preserved and stabilized, usually by sticking it onto a board. This assemblage is then framed to safeguard the peel during handling and carriage.

Penetration of lacquer or resin is the result of capillary forces in air-filled soil pores.

Soils of arid regions

Arid or semi-arid soils are usually calcareous and dry unless irrigated. They are hard, often cemented and may contain concretions, caliche or hardpans. Loamy and clayey soils normally have strong, often angular structures and may have a cracked surface. Residual soils may be stony and shallow.

Although their properties make successful peels more difficult to prepare, an arid climate facilitates field methods and speeds up production in the absence of adequate indoor facilities.

Techniques for soils of arid regions

Calcareous soils Profile lacquer does not easily adhere to or penetrate into a dry calcareous soil. Such a soil is hard when dry, in particular the calcic horizon, and little soil will remain attached during Stage 3. Adhesion can be greatly improved by repeatedly wetting the soil face or the calcareous part of it with water, preferably as a fine spray to avoid run-off and micro-erosion. Lacquer should be applied as soon as the moisture soaks in. Most calcareous soil is soft then and the covering film of lacquer will keep it that way. As a result separation is easier and Stage 3 can be completed successfully. The fresh peel will be fragile, however, and should be left to dry and harden before carriage.

Clayey soils Apart from being often calcareous, dry clayey soils are an extremely difficult material for making a soil peel. The soil is hard when dry and difficult to moisten, so Stage 1 is laborious. Stage 2 could fail because lacquer hardly penetrates, even when the clay is moist, causing poor fixation (where it ought to be very good) of the heavy structural elements. The following technique overcomes the difficulties in Stage 1 and 2.

a. The profile wall, preferably cut vertically, is evened off immediately after digging the pit. Repeated moistening may help.

b. The profile face is then left *to crack*. In hot dry weather, it should start to crack overnight and the face should be shaded during the day to avoid unnatural cracks. The lacquer should be applied when cracks are 2–4 mm wide. The lacquer should be rather thick so as not to penetrate too deep into the cracks but just enough to hold each structural element in place. Stages 3 and 4 in clayey soils can be as described in the section 'Soil peels from a vertical wall'.

Soils with stronger structure Dry calcareous soils, especially if loamy or clayey, commonly have a moderate or strong structure with elements which are hard or very hard when dry, often platy or prismatic at a certain depth. The peels in arid regions should therefore be taken from a *vertical* rather than a slanting wall. Authors describing peeling procedures for soils with structure in temperate climates have also recognized the advantage of vertical peels. They suggest an approach to vertical, by using a steel sample box (which can be pushed into the soil) or by carving out a true monolith that fits into a wooden box. Both these methods of making vertical peels are extremely difficult in dry soils because of their hardness. A disadvantage of the lacquer-pouring method is that the wall has to be sloped to obtain adequate penetration of lacquer (poured from above) around protruding concretions and stones and into holes and spaces, which are so numerous in dry soils.

The field method below was therefore used for applying lacquer to a vertical wall and for preparing a peel of dry calcareous, loamy or clayey soil.

Soil peels from a vertical wall

Advantages:

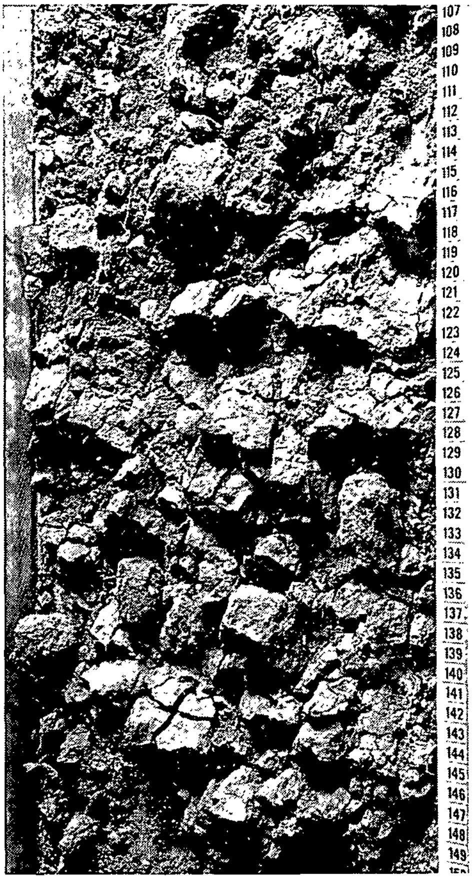
1. The depth of the horizons are natural and profile measurements, made vertically on the spot, need not be adjusted.
2. Shapes of soil structures are more natural. Prismatic or platy structures look very unnatural from a sloping wall, with broken-off prisms and plates which point out and downwards at an angle equal to the slope of the wall. Compare Fig. 1 with Fig. 3B and Fig. 2 with Fig. 4B. Slickensides will mostly be hidden under protruding elements.
3. Equal lengths of peels from vertical walls cover a deeper section of the soil than from slanting walls.

Manual of the field procedure

Stage 1: The face is best evened off by following the descriptions of the previous section for the various kinds of dry soils. The wall should be vertical or nearly vertical. The face is treated or prepared for the lacquer as already described for various kinds of dry soils.

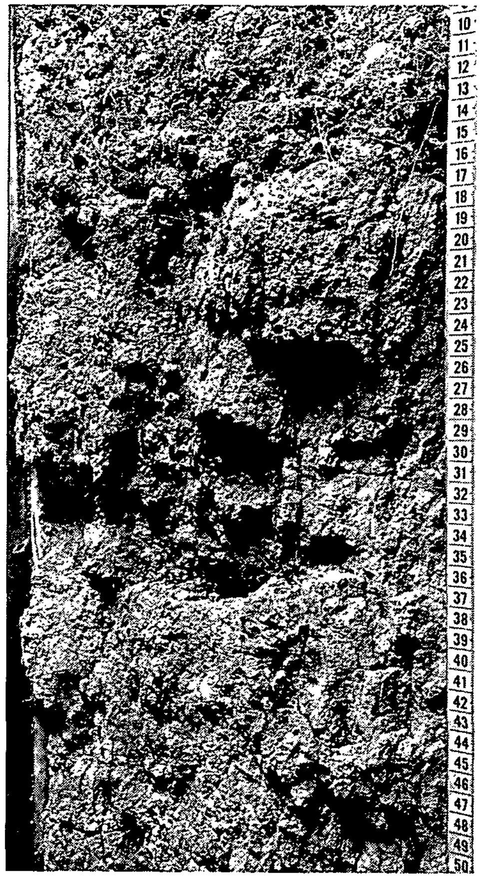
Stage 2: Lacquer cannot be poured onto the vertical wall. Instead the lacquer *is pushed slowly upwards* from bottom to top with a pushboard (a pulley-belt nailed on a piece of wood with two handles), whilst an assistant pours on to it, keeping an ample supply between pushboard and wallface. In this way, the lacquer will spread over the face and flows and penetrates into holes and cracks (see Fig. 4A). The pushboard should be about 2 inches (5 cm) wider than the desired peel-width and should be pressed very gently against the wall, to avoid disturbing its structure. Lacquer should not be sprayed in an arid climate. Results are better at sunset or at least in the shade. After hardening, lacquer was applied again in like manner and a piece of wide-mesh jute, cheese-cloth or plastic mosquito screen is rubbed into it as a reinforcement. This protects the peel from damage during Stage 3, carriage or storage.

Fig. 1. Soil peel from oblique wall face.
Note protruding and broken-off prismatic structure elements. Depth in cm.



Şekil 1. Düşey duvar yüzünden elde edilen toprak monoliti. Dışarıya doğru çıkan ve kırılan prizmatik strüktür elementlerine dikkat ediniz. Derinlik cm. olarak.

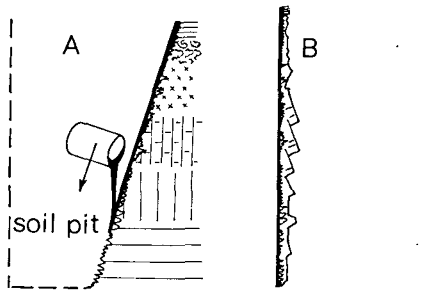
Fig. 2. Soil peel from wall face.
Natural presentation of prismatic structure elements. Depth in cm.



Şekil 2. Duvar yüzeyinden elde edilen toprak monoliti.
Prizmatik strüktür elementlerinin tabii görnüşü. Derinlik cm olarak.

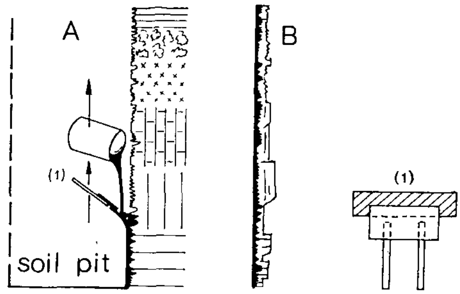
Stage 3: After hardening the reinforced material, the peel may be cut and pulled from the wall as is common with thin peels of sandy soils. But if the peel bends where it is pulled loose, it may crack horizontally (Fig. 5A). Heavy peels of clayey soils are completely spoiled then. Particularly for the arid soils described in the section 'Techniques for soils of arid regions' the back of the peel should be strengthened in the field before peeling, with a board. This can be done best by sticking a flexible sheet of masonite onto the cloth-reinforced face of the profile, i.e. the future back of the peel. If the board and the back of the peel are covered with rubber glue and pressed together, they immediately bind firmly. Ordinary rubber solution suffices but special

Fig. 3. Cross-section A: The application of profile lacquer to an oblique wallface direct from the can. Penetration into deep cracks or holes is often insufficient.
Cross-section B: Presentation of structure on resulting soil peel is unnatural.



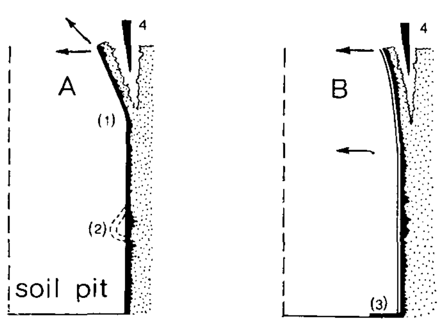
Şekil 3. Kesit A: Kutudan doğrudan doğruya düşey duvar üzerine profil lakının tatbiki. Derin çatlaklara veya deliklere lakın girmesi genellikle yetersizdir.
Kesit B: Elde edilen toprak monolitinde strüktürün görünüşü tabii değildir.

Fig. 4. Cross-section A: The application of profile lacquer to a vertical wall face by means of a wooden pushboard with rubber rim (1) Note better penetration of lacquer into cracks and holes.
Cross-section B: Presentation of soil structure is true to nature.



Şekil 4. Kesit A: Kenarı lâstikli lak sürme tahtası ile profil lakının düşey duvar üzerine tatbiki (1) lakın çatlak ve deliklere daha iyi girmesine dikkat ediniz.
Kesit B: Toprak strüktürünün tabiattaki haliyle görünüşü.

Fig. 5. Separation of soil profile peel from soil mass.
Cross-section A: by pulling peel with back of lacquer and cloth only.
Cross-section B: by pulling peel with 'backbone' of masonite board.
1 = horizontal cracks may develop here,
2 = heavy peels may shear from soil mass and fold here,
3 = support (piece of wood) placed under assembly will prevent soil shearing, and
4 = cutting edge of spade.



Şekil 5. Toprak kitlesinden toprak monolitinin alınması.
Kesit A: Lakın arka tarafından ve yalnız telis bezden toprak monolitinin çekilerek alınması
Kesit B: Omurga olarak masonit mukavva vasıtasiyle toprak monolitinin çekilerek alınması.
1 = yatay çatlaklar burada ezilmeler oluşmaktadır,
2 = ağır toprak parçaları toprak kitlesinden dağılabilir ve bu noktada kırılabilir,
3 = Bir kaç kişinin yardımıyla (bir tahta parçasıyla) toprağın dağılması önlenecektir.
4 = küreğin kesen kenarı.

rubber contact glue like Bisonkit or Pattex made in the Netherlands and Germany respectively, are better if used properly. A secondary advantage of reinforcing with masonite in the field is that it can be used as a template for cutting the peel to size, without disturbance. Before glueing, the masonite sheet (which should be cut to the desired peel measurements) is pressed against the lacquered face after which its contours are cut deeply through lacquer and cloth into the soil. The peel ought to be 0.5 inch (1.5 cm) narrower than the board, to allow for easier framing.

Shortly after the masonite sheet has been applied, the profile can be peeled almost undisturbed by cutting and gently separating the board-backed peel from the mass (Fig. 5B). For clayey soils a blanket of soil, at least 3 inches (8 cm) thick should be cut loose in order to preserve the structural elements. Excess soil should not be removed until elements have dried and hardened.

Successfully separated peels have to be fitted into a rigid wooden frame at once, to avoid damage during removal from the pit and during carriage (section 'Packing for transport'). The peel can be fixed to the frame with glue or lacquer after arriving home and then the whole assembly should be left on its back for several days to let the soil and lacquer dry.

After excess soil has been removed the soil peel can be exhibited or stored upright. Horizon names can be indicated on the sides of the frame. The field profile description may have to be revised because the peel may reveal new characteristics.

Packing for carriage

Soil peels are very fragile and should be handled with extreme care to maintain their important natural features.

A fresh peel must be put straight away into a wooden frame and kept horizontal until it has been glued there. An adequate frame of rigid construction is shown in Fig. 6A and B.

The hard timber frames should be made to standard dimensions to allow stacking even if some peels are smaller. Several framed peels can be transported by road, rail or sea as in Fig. 6C and D.

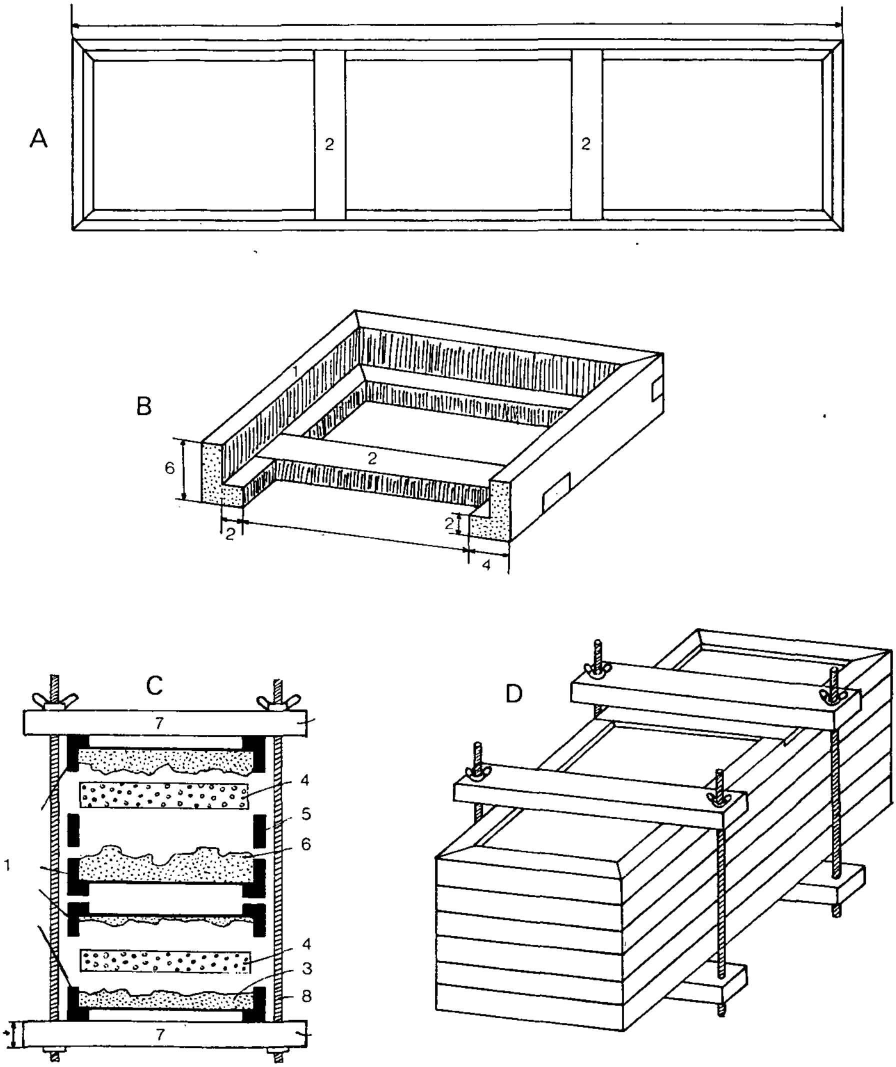
The framed peels are stacked in pairs with a full-sized sheet of 5 cm (2 inches) thick plastic foam sandwiched between them and then secured by screwing the two clamps shown, until wood touches wood. The soil peels must clear each other but every bit has to be under the slight pressure of the foam. Very thick peels protruding beyond the rim of the frame should be seperated by inserting an extra 'extension frame' as shown in the diagram.

Wood-wool, hay or fine straw may be used instead of foam plastic in emergency. Such a package can stand rough transport without disturbance of the peels. The foam plastic sheets can be used again.

Fig. 6 A and B: Details of construction of a soil peel frame and suggested dimensions (in cm). 1 = frame rim, 2 = cross members.

C: Schematic cross-section through stack of framed soil peels with clamp, 1 = frame rims, 3 = soil peel, 4 = foam plastic, 5 = extension frame, 6 = very thick peel, 7 = piece of wood, and 8 = threaded rod.

D: Package of soil peels ready for transport.



Şekil 6 A ve B. Detaylı olarak toprak monoliti çerçevesinin yapısı ve teklif edilen boyutları (cm olarak) 1 = çerçeve kenarı, 2 = çapraz parçalar.

C: Bağlama vidalariyle çerçevelenmiş, ve üst üste istiflenmiş, toprak monolitlerinin kesiti.

1 = çerçeve kenarları, 3 = toprak katı, 4 = köpük plastik, 5 = uzayan çerçeve, 6 = çok kalın toprak katı, 7 = tahta parçası, 8 = dişli çubuk.

D: Taşınmaları için hazırlanmış toprak monolitleri.

Estimation of production cost

The preparation of soil peels is more costly and time-consuming than is often realized. Table 1 specifies the costs in US dollars (1969). The estimate is based on the production of one soil peel (1 × 6 ft or 30 × 180 cm) of a dry calcareous soil, made from a vertical wall according to the techniques described in this paper. The following assumptions are also made:

1. The team, making the peels, consisted of a graduate soil scientist and a field assistant.

b. This team is part of a soil survey party. So the making of soil peels is only part-time work. Cost of digging and tools are not accounted.

c. The profile site is about 10 miles (16 km) from base.

d. Except for the imported lacquer, prices are based on local standards in Turkey.

The estimate of US dollars per soil peel would be cut by 10–20% if ordinary but less suitable polyvinyl acetate and acetone were bought locally or if labour were cheaper and if several profiles were prepared on one trip.

Table 1. Estimate of cost in US $ for the production of one soil peel

Cost of materials		
Nitrol profile lacquer and Nitrol thinner[1]		
2500 ml at $ 10.00 for 10 litres (from factory)	2.50	
Carriage and customs duty for Nitrol	5.00	
Board (masonite) 30 × 150 cm	2.00	
Jute or cheesecloth 30 × 150 cm	1.00	
Rubber solution 500 ml	1.00	
Wooden frame	3.50	
		$ 15.00
Cost of carriage		
3 trips by Land Rover or jeep from base to profile site		
60 miles at $ 0.25 per mile		15.00
Salaries peeling team		
3 trips of 3 hours each 9 hours		
Framing, finishing 3 hours		
Total hours/man 12 hours or 1½ working days		
Soil scientist (graduate) at $ 16 per day[2]	24.00	
Field assistant at $ 4.00 per day[2]	6.00	
Total		30.00
Failures 20%		12.00
Real cost per peel		$ 72.00

1. Manufactured by Pieter Schoen NV, Zaandam, the Netherlands.
2. Including overhead costs and field allowance.

Tablo 1. Bir Toprak monoliti yapmak için gerekli tahmini harcamalar (US$ olarak).

On both travel expenses and time could be economized considerably more if a lacquer or resin would be used that is combining the excellent penetration and adhesion properties of Nitrol profile lacquer with a short enough hardening period to allow the whole procedure to be finished in a few hours. The author would be grateful for further suggestions.

Özet

Arazide yapılan izahlarıyla birlikte, '*tabii toprak kesitlerinin*' toprak morfolojisi, toprak sınıflandırması ve öğretim sahalarında büyük önemi vardır.

Tecrübe neticesi olarak, büyük Konya havzasında başarılı tarla metodları elde edilmiş ve

a. kuru, kireçli topraklardan, özellikle killi topraklardan tabii toprak kesitlerinin hazırlanması ve
b. özellikle kuru topraklarla ilgili olarak meyilli kesit yerine düşey tabii toprak kesitlerinin hazırlanması izah edilmiştir.

Hazır tabii toprak kesitlerinin nakli konusu üzerinde taysiyelerde bulunulmuştur. Türkiyede bir "*tabii toprak kesitinin*" kaça mal olduğuna ait bir hesap örneği verilmiştir. Bu husasta yapılan tahmin, çalışmanın yapıldığı yere ait, mümkün olduğu oranda kullanılan personel ve materyal'e dayanılarak yapılmıştır.

For a complete list of references see de Meester, T. & J. Bouma in Neth. J. Agric. Sci. 15 (1967): 63–74.

Equipment and use of a mobile field laboratory

P. M. Driessen & T. de Meester

Abstract

A mobile laboratory was installed in a Land-Rover camping version (Dormobile) and a trailer with an electric generator and air-conditioning unit, to test its practical value in soil survey and to lessen the need to carry soil samples to the Netherlands.

This unit operated for some 10 months in Central Anatolia. Its equipment allowed rapid routine analysis for most tests currently necessary in soil survey.

Also salinity could be almost completely tested, including estimation of K^+ and Na^+, Cl^- and SO_4^-, on 20 saturated paste extract samples per day, totalling 200 estimates. A complete inventory of the laboratory is given. The greatest disadvantage was its susceptibility to dust and wind and therefore a dustproof caravan-trailer would be better.

Introduction

Many soil scientists would like to have a kind of a simple field laboratory to carry out soil analysis on the spot or at least in a fieldcamp.

Mobile laboratories are commonly used in soil testing for road construction but rarely in agricultural soil surveys. During our field studies in Turkey we decided to equip a special Land Rover. Its purpose was routine analysis of soil samples on the spot in order to speed up the survey and to decrease the number of soil samples that had to be taken to Wageningen.

A choice had to be made between:

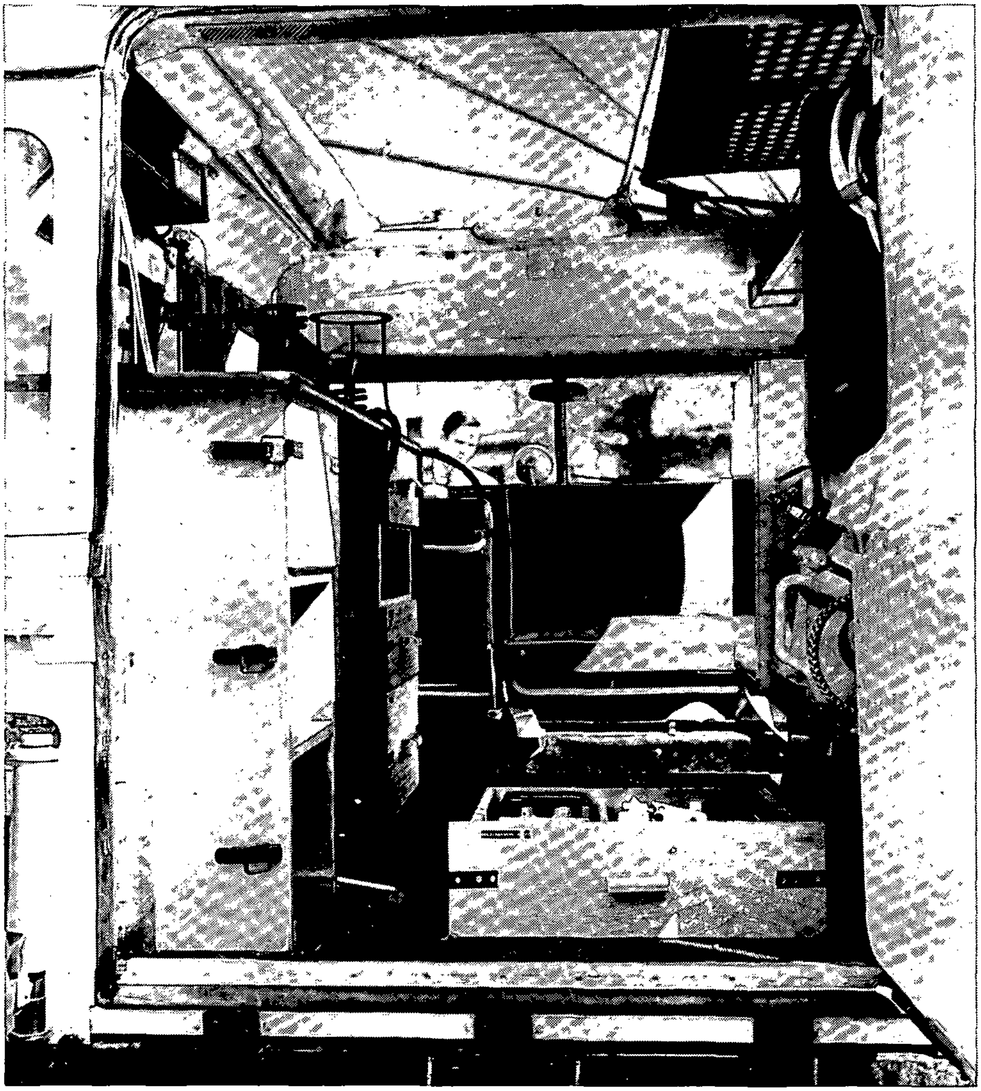
1. A small mobile field laboratory of high versatility, which is equipped for simple and accurate routine determinations or
2. a caravan-type field laboratory to be stationed at the basecamp fitted for a larger range of soil analysis possibilities.

During the field seasons of 1966 and 1967 a mobile field laboratory of the first mentioned type was used and experience was gained with its most efficient operation.

Technical description

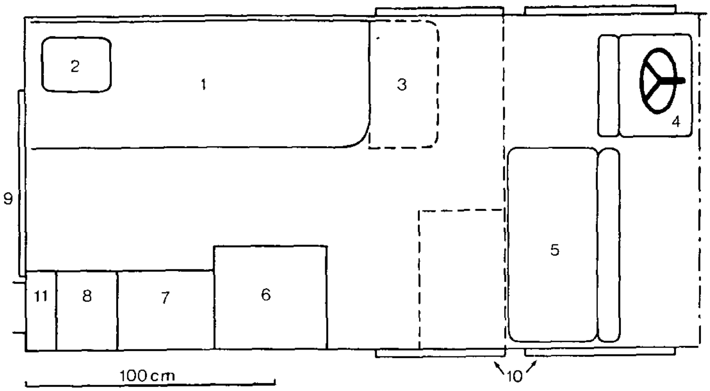
The labmobile Mainly because the Project already possessed 2 Land Rovers, a Dormobile version of the Land Rover long station car was chosen for conversion as a field laboratory, hereafter called a Labmobile.

Fig. 1. View in the Labmobile through backdoor. At left side working bench with standard size drawers (one on the floor). At right side box for analytical balance, frigidaire and waterpurifier. Upper left hammock folded, at right extended. Middle passengers seat in reversed position.



Şekil 1. Arka kapısından Labmobilin içinin görünüşü. Sol tarafta standart ölçülerde çekmeceleri olan (birisi döşeme üzerinde) çalışma masası. Sağ tarafta hassas terazi kutusu, buz dolabı ve su damıtıcı Daha sol üstte katlı branda yatak, sağa doğru uzanmaktadır. Ortada değiştirilmiş durumda yolcuların oturacağı yer.

Fig. 2. Groundplan of Labmobile.



1. Working bench
2. Small sink
3. Collapsible bench
4. Drivers seat, pushed foreward
5. Passenger seat reversed
6. Box for analytical balance
7. Fridgidaire
8. Watertank and de-ionizer
9. Backdoor
10. Side doors
11. Air duct

1. Çalışma masası
2. Küçük kap
3. Açılıp kapanabilir masa
4. Sürücüler için oturak, öne doğru sürülmüş
5. Yolcular için oturak, ters
6. Hassas terazi için kutu
7. Buzdolabı
8. Su deposu ve damıtıcı
9. Arka kapı
10. Yan kapılar
11. Hava bacası

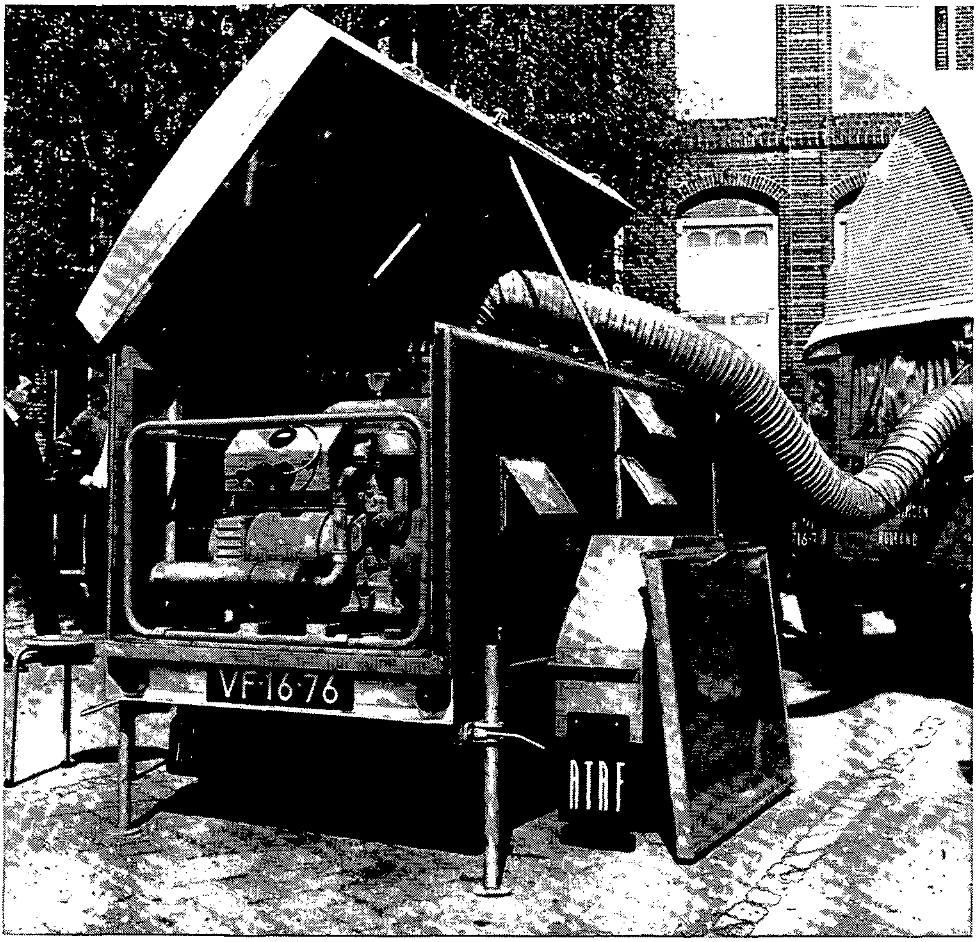
Şekil 2. Labmobilin temel plânı.

This vehicle was manufactured by Land Rover and Martin Walter for camping and exploration and therefore fitted with reclining seats, an extensible roof (providing ample headroom, when standing upright) and 2 hammocks above the roofline. The two rear seats, the standard sink and a cupboard were removed to make room for a working table (170 × 50 cm) and the instruments. During travel there was room for four persons and during use as laboratory for three persons to work and write. In both conditions two persons may rest or sleep in the hammocks without disturbing the instruments in the car (Figs. 1, and 2).

Bright 12V TL lights and butane tanks for the burner were standard equipment. The windows were screened against insects.

The trailer A car standing unprotected in the sun very soon becomes unbearably hot inside. The Labmobile was therefore cooled with an air conditioner powered by a 220 V electric generator (capacity 4 KVA) with an 8 hp petrol engine. Both generators had to be housed in a trailer (Figs. 3 and 4). The cool air was blown into the vehicle through a flexible pipe. In operation the trailer should be detached to avoid vibration. The generator engine was very quiet, because of an extra silencer.

Fig. 3. Electric generator and cooling unit in trailer. Note the tube for cool air to Labmobile.

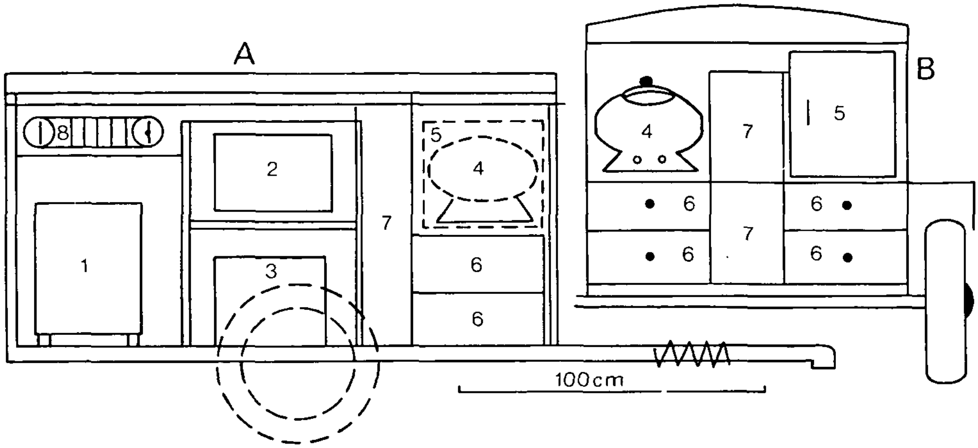


Şekil 3. Treylerde elektrik jeneratörü ve soğutma teşkilâtı. Dikkat tüp Labmobile serin hava temin etmektedir.

It had enough space for an extra large fuel tank, jerrycans for water, the airpipe, a centrifuge and an electric drying oven (both 220V) and drawers for equipment, glasswork and chemicals. The drawers of the trailer and those of the Labmobile were changeable. Some were labelled as 'pH drawer', 'salinity drawer' and 'powertool drawer'.

The trailer had the same type of wheels and tyres and the same axle length as the Labmobile. Its gross weight was about 600 kg. It was fitted with a push brake.

Fig. 4. Trailer. A. Side elevation. B. Front elevation.



1. Electric generator
2. Cooling machine
3. Compressor and heat exchanger
4. Centrifuge
5. Drying oven
6. Standard size drawers
7. Packing space
8. Folded airtube.

1. Elektrik jeneratörü
2. Soğutucu makina
3. Kompresör ve sıcaklık değiştirici
4. Santrifüj
5. Kurutma dolabı
6. Standart ölçülü çekmeceler
7. Paketleme yeri
8. Eğilmiş hava tüpü

Şekil 4. Treyler. A. yan yükseklik. B. ön yükseklik.

Instruments

An inventory of instrumens is given in the Inventory list. Only the most important instruments are mentioned here.

Analytical balance The type used could be easily fixed for travel so that nothing shook and the knife edges were protected. The instrument was packed in a box padded with foam plastic and could be prepared for use within 10 minutes.

Weighing was semiautomatic, capacity 100 g and sensitivity 1 mg. After the Labmobile had travelled over 20,000 km, there was not the slightest damage.

Scale For weighing soil and chemicals an ordinary triple beam scale was used with a capacity of 2.5 kg and a sensitivity of 0.1 g.

pH meter A portable battery-operated type with a combination cell was used with a sensitivity of 0.2 unit. It was normally stored in the 'pH drawer' of the Labmobile, but could be carried in a leather case.

Conductivity bridge A portable battery-operated type was used with a range of 0–3 $\times$ 10^5 μmho/cm, an ECe scale, and adjustments for temperature and state of battery. It also had a special drawer. The cells used for measuring ECe were Philips type PR 9513/00.

Flame-photometer An extremely small type was used for estimating K^+ and Na^+ against standard solutions. The instrument was easy to operate. Air pressure was provided by a small electric (220V) compressor. The flame was fed from the butane tanks of the Labmobile.

Marius Chlor-O-Counter A small instrument for the rapid determination of Cl^-.

Frigidaire An adsorption refrigerator, capacity 8 litres, was permanently installed in the Labmobile. It ran on 12 V DC (car battery) or 220 V AC and could be converted to butane if necessary. The refrigerator was used for keeping cool standard solutions and beverages.

Water demineralizer A portable 2 column deionizing unit, capable of producing about 5 litres ion-free water per minute, was indispensible for all sorts of chemical analysis. A small battery-operated conductivity meter was incorporated to allow a constant check on water quality. Regeneration of the active resin columns was easy.

To obtain sufficient water pressure in the Labmobile the purifier was supplied from a special storage tank, in which air could be compressed with an ordinary footpump.

Binocular microscope Soil morphology was studied with a stereomicroscope magnification $\times$ 10 to $\times$ 100.

Stereoscope A folding-mirror stereoscope was used to interpret aerial photographs.

Centrifuge A small centrifuge (diameter 40 cm), capacity 4 tubes of 100 cm^3 and maximum speed of 5000 rpm, was used for preparing saturation extracts and for estimating CEC (cation exchange capacity) and ESP (exchangeable sodium percentage).

Electric drying oven A single wall stove with a capacity of 18 litres was used for drying samples, such as soil and plants. The temperature was thermostatically controlled up to 150°C.

Soil analysis capacity

With all the equipment of Labmobile and trailer the following soil analyses could be carried out. Those requiring the trailer are asterisked.

1*. Preparing the saturated extract and estimating Saturation Percentage (SP) by drying and weighing.

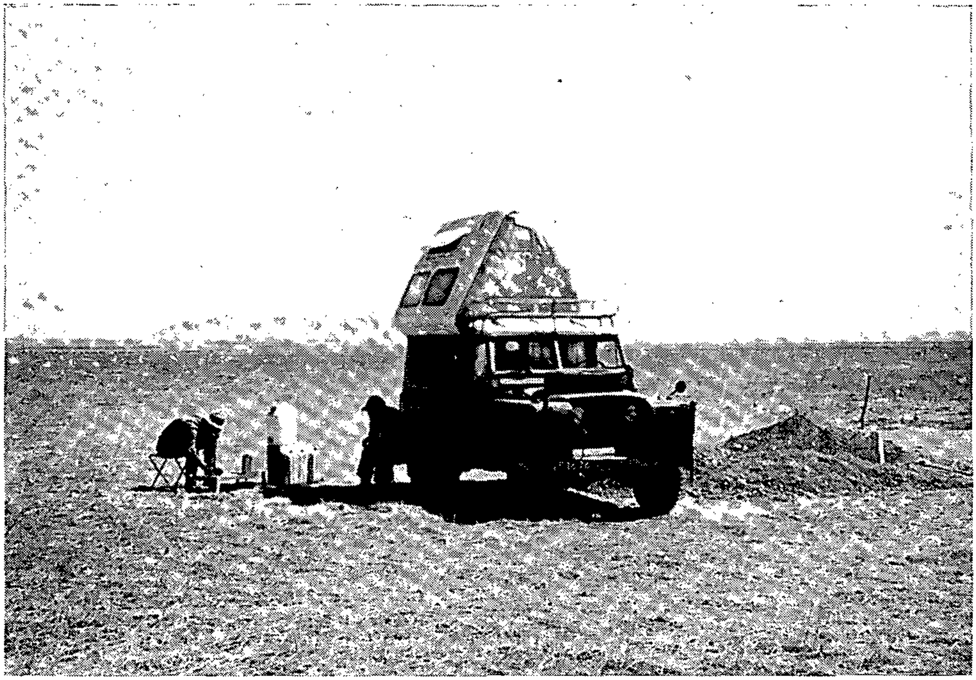
2. Measuring electrical conductivity of the saturation extract (ECe). This extract was obtained by centrifuging a portion of the saturated paste.

3. Measuring pH in the paste and in the extract. For soil paste no combined electrodes could be used.

4. Estimating carbonate and bicarbonate by titrating a portion of the saturation extract with dilute sulphuric acid. The pH of the solution could be checked by colour indicators or with a pH meter.

5*. Estimating chloride in the extract with a Chlor-O-Counter automatic device. The chloride is precipitated with silver from an electrode. The amount of silver removed from the electrode is correlated with electric current, which is measured as a number

Fig. 5. The Labmobile in the field without trailer.



Şekil 5. Treylersiz Labmobilin tarlada görünüşü.

of counts.

6*. Sulphate was precipitated as Barium sulphate in ethanol with thorin indicator. To prevent heavy metals from interfering with the colour change, they had to be removed by passing the extract through a column of a cation resin before titration.

7*. Calcium and magnesium were titrated with Versenate. Calcium was not regularly estimated.

8. Sodium and potassium were measured with the flame-photometer.

9*. Carbonate was estimated by Wesemael's method. Samples are treated with hydrochloric acid and the increase in weight as CO_2 replaced the lighter air was measured. The method was simpler and quicker than the commonly used Scheibler method.

10*. Cation-exchange capacity (CEC) and the exchangeable sodium percentage (ESP) were estimated by methods in the United States Department of Agriculture Handbook 60.

11*. Nitrate and boron were detected by colour tests. $CaSO_4$ was estimated qualitatively by precipitation with acetone from an aqueous extract.

12*. Especially for analysis of irrigation water dissolved matter was estimated by evaporating and weighing a pipetted portion. The hardness of irrigation water was calculated from its content of $Ca^{2+} + Mg^{2+}$, estimated as above.

As an indication of the working capacity, an analyst and his assistant were able to analyse 20 saturated paste extract samples for anions and cations, (about 200 estimates per day) for a period of several weeks in 1966.

Discussion

Advantages Labmobile and trailer together form a large adaptable mobile unit. The unit can operate independently, providing reasonably comfortable working and living quarters for 2 or 3 occupants, day and night in any climate. The unit could reach remote sites but should keep to roads and tracks because of the heavy trailer.

If the trailer has to be left behind, the Labmobile alone is still self-supporting for light and gas but less variety of analysis is possible (Fig. 5). Some cooling was possible from cheap 12V fans normally used for demisting car windscreens.

If the Labmobile was needed for travel all instruments and equipment (except the working table) could be removed from the vehicle and installed in a tent or house. The trailer was still used for generation of electric power and cooling.

Disadvantages The main disadvantage of the Labmobile was its susceptibility to dust. A Land Rover is not dust-proof so that the interior had to be cleaned over and over again, even after a very short trip, before the analysis could begin.

For long-term use the interior was very cramped and full day's work became hard labour.

Finally the Labmobile was unstable because the extended roof caught the wind. Even with hydraulic jacks on the four corners (Fig. 1) small movements could not be eliminated.

Conclusions and recommendations The Labmobile and trailer in their described form have been used for two seasons and in total for nearly 10 months in the Great Konya Basin. We found this mobile unit very practical and successful for a small survey party and for simple laboratory work on the spot and for written work at night in a quiet and well illuminated environment.

However, for more elaborate soil analysis as for studies on salinity or soil fertility we recommend a Caravan trailer instead of a Labmobile.

There is a wide selection of medium-sized, dustproof and well isolated caravans easily converted into a small laboratory. Such a caravan could be stationed at base camp. Like the Labmobile it is readily mobile and would give more privacy than a tent and could be cooled more easily.

Inventory list

Instruments

	Approximate value in US dollars (1969)
1 Sartorius Analytical Balance 0–200 g	390
1 Ohaus scale, triple beam 0–1000 g	40

1 Electrofact pH meter + combined electrodes	180
1 Cenco battery-operated conductivity bridge + cell	350
1 Christ table-centrifuge	420
1 EEL flame-photometer	500
1 Cenco vacuum-pressure pump	85
1 Marius Chlor-O-Counter	500
1 Zerolit portable demineralizer	220
1 Cenco electric oven (220 V)	85
1 Sivia Frigidaire refrigerator	110
1 Metrohm piston burette 10 ml	55
	$ 2935

Glasswork and small equipment Total value about $ 250: spoons and spatulas, thermometers, polyethene bottles 500 ml, Bunsen burner, beakers (polythene) of different size, calibrated bottles of different size, weighing cups, watchglasses and pipettes of different size. Furthermore 50 conical flasks of different size, funnels (polythene), centrifuge tubes (plastic) and some other items like a plastic desiccator, electric stirrers (12 V) and a cation resin tube.

Özet

Toprak etüdlerinde, daha ziyade deneyler için olduğu kadar, böylece aynı zamanda Hollanda'ya getirilmesi gerekli toprak örneklerinin miktarını azaltmak bakımından, beraberinde römork ve elektrik jeneratörü bulunan, hava cereyanlı, Landrover Kamping, diğer bir deyimle *Dourmobil* tesis edilmiştir. Bu tesis 10 ay süre ile Orta Anadolu'da çalışmıştır. Bu ekipmanla toprak etüdlerinde geçerlikli ve çabukça elde bulunması gerekli toprak analizlerinin yapılması mümkün kılınmıştır.

Yine, hemen bütün tuzluluk deneyleri silsilesinin; Cl^-, $SO_4^=$, Na^+, K^+ iyonlarının tayinleride dahil olmak üzere hergün ortalama 20 doygunluk çamuru ekstraktı örneği veya 200 analiz yapılması gerekli kılınmıştır. Bu husustaki envanterlerin tümü verilmektedir. En büyük dezavantajı toz ve rüzgâra karşı hassas olmasıydı, bu sebepten ötürü, toz çatısı bulunan kervan römork tercih edilmiştir.

Remarks on the geomorphology of the border region of the Great Konya Basin

D. J. G. Nota, C. G. E. M. van Beek

Abstract

The Great Konya Basin contained a Pleistocene lake basin, now dry, with associated shore features and the piedmont zone. The lake bottom was a featureless plain about 1000 m above sea-level. The abandoned shoreline exhibited rock cliffs and various types of beach ridges. The piedmont zone consisted of a series of Neogene Limestone Terraces partly covered by Bajadas and Alluvial Fans. In the Bajadas there were at least two depositional phases, and, in the Alluvial Fans prominent terraces, as of the Sille near Konya, reflected changes in their depositional sequence.

Introduction

A geomorphological reconnaissance across the border of the Great Konya Basin revealed a number of distinct morphological units. They consist of a Pleistocene lake basin, now dry, with its associated shore features and the piedmont zone. Beyond are the mountains which rise some 500 or 1000 m above the Basin (Fig. 1).

This paper discusses briefly the geomorphological units and their associated deposits along the rim of the Basin with some remarks on the late Pleistocene and Holocene depositional history.

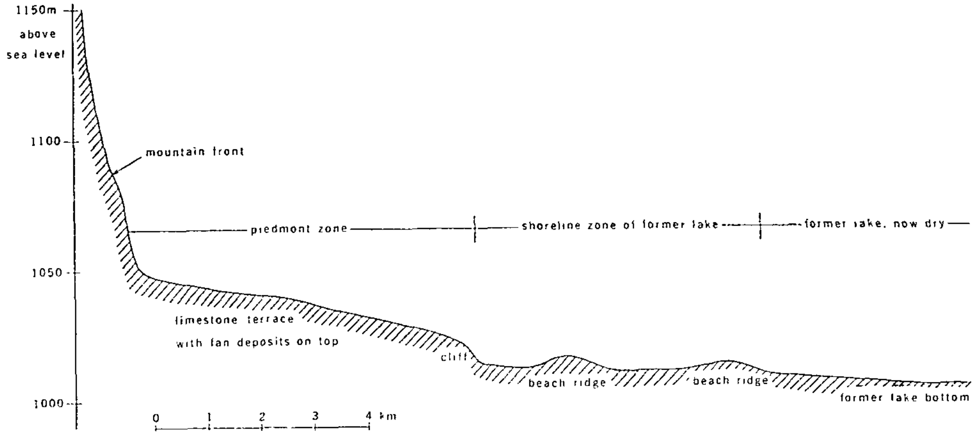
A general account of the geomorphology of the Great Konya Basin is given in Part A (Chap. 3).

The lake bottom

The bottom of the former lake forms an almost featureless plain, about 1000 m above sea-level. The lake deposits consist mainly of marl. The carbonate component makes up 50–80 %. Particle size distribution was mostly in the clay and silt range. The non-carbonate contained 30–65 % of the fraction smaller than 2 μm. Since the non-carbonate component decreases in amount with increasing distance from the former shoreline, it appears to have reached the lake by rivers. Most of the carbonate was probably supplied as clastic particles derived from the limestones bordering the Basin, although part of it may have accumulated by biogenic processes.

The total thickness of the clastic sediments in the Basin is unknown, but thicknesses over 400 m have been recorded (de Ridder, 1964,) in narrow curved strips, one running from Demirkent to Divanlar, another from Ereğli to Karaman.

Fig. 1. Cross-section through border of the Konya Basin.



Şekil 1. Konya havzasından sınırına doğru bir kesit.

Shoreline features

The abandoned shoreline is the main evidence for the existence of a former lake. Both erosional and constructional forms can be recognized along the 1017 m level. These features were first described in some detail by Louis (1938).

Rock cliffs, some of which contain niches, represent the main erosional forms along the abandoned shoreline. They are most common along the north of the Basin, apparently due to the prevailing wind direction and fetch. Various types of beach ridges such as barrier spits, bay barriers, tombolos and bars are the main constructional forms found along the old shoreline; for system of classification, see Shepard (1963). These ridges consist of gravel, sand and large quantities of shells and shell fragments belonging to a fresh water fauna. The beach ridges on the north of the Konya Subbasin contain more gravel than those on the south. This suggests that sand-size material has been removed from the northern beaches and has migrated around to the southern shore. Mineral analysis of the various sands could be used to reveal the patterns of sediment distribution along the old shoreline.

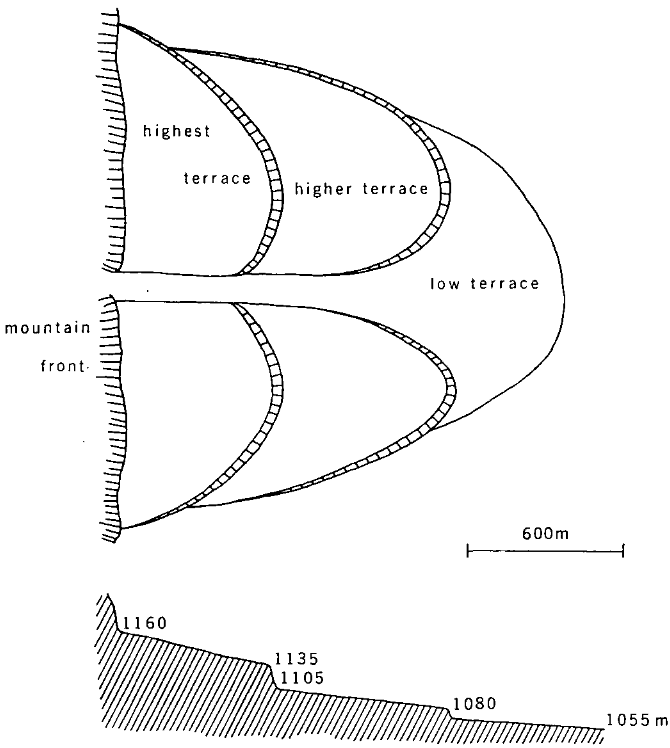
Piedmont zone

The piedmont zone between the abandoned shoreline and the mountains consists of a series of Neogene Limestone Terraces, partly covered by Bajadas and Alluvial Fans.

The Limestone Terraces occur at different levels between 1000 and 1070 m and cover large areas around the edge of the Basin. They are best developed in the areas south of Çumra, north of Demirkent and north-west of Ereğli. The nearly horizontally stratified hard whitish to gray limestones dip slightly towards the Basin. Locally, these terraces have been traversed by gullies, which sometimes cause an undulating topography. At their mouths the morphology indicates that the gullies were active when the lake existed. The gullies represent the remnant of a drainage system in the piedmont zone during the lake period. This dissected topography is especially well developed between Çumra and Karaman.

Bajadas or alluvial piedmont plains form the second major morphological unit in the piedmont zone. They form extensive almost flat areas and have developed by coalescence of the distal ends of several alluvial fans. Bajadas cover large areas of the Neogene Limestone Terraces. The deposits consist of subangular gravel mixed with pelite. The bajada deposits vary in composition. Deposits containing limestone, volcanic debris, and metamorphic rock fragments have been found. At several places at least two depositional phases can be distinguished. Vertical profiles (about 1.50 m thick) show from bottom to top an alternation of gravel-size and sand-pelite-size material. This sequence appears to represent repeated changes in the depositional history of the area, but it has not been investigated regionally.

Fig. 2. Simplified diagrams showing alluvial fan segmentation along the River Sille.



Şekil 2. Sille çayı boyunca alluvıyal fan segmentasyonunun basitleştirilmiş diyagramı.

Alluvial fans are found at the foot of the mountains where the streams emerge such as along the western rim of the Basin near Konya. The fans form cones of usually coarse-grained debris, deposited mainly in stream channels. Prominent terrace levels in the alluvial fan bodies such as of the Sille near Konya and of the Çay near Sadye, 20 km north of Konya, reflect changes in their depositional sequence (Fig. 2). Two high terraces and a lower one can be recognized in each of these places.

The highest terrace consists of consolidated almost horizontally layered gravel and sand deposits. Unconsolidated gravel and sand deposits form the two lower terraces. The terraces are considered to be younger with decreasing elevation, the highest one being the oldest. The youngest terrace is being dissected.

The terrace levels do not coincide with former lake levels.

Tectonic movements or changes in climate are the main factors in the terracing or segmentation of alluvial fan bodies. Bull (1964) showed that the youngest fan segment is always found at the highest level in the series near the mountain front, when tectonic movements are the main cause for terrace development. Since the oldest terrace occurs nearest to the mountain front in the Konya Basin, tectonic movements do not appear to control the fan segmentation. Hence climatic changes during fan deposition must be considered as a major cause of fan-terracing in the Konya Basin.

Conclusion

The reconnaissance across the border zone of the Great Konya Basin has outlined the major morphological units and their associated deposits. This is a basis for the physiographic soil classification in the Basin. However, the limited data available from this reconnaissance does not allow any worthwhile speculation on the recent depositional history. In particular we found the lack of available detailed topographic maps as a draw back. Promising areas exist for further study of the late Pleistocene and Holocene history of the Konya Basin. A detailed study of the alluvial fan bodies and their segmentation in relation to the repeated depositional sequence in the bajada deposits would be most rewarding.

Özet

Büyük Konya havzası, halihazırda kurumuş bulunan pleistosen göl tabanı ve bununla ilgili olarak kıyı oluşumları ve piedmont bölgesinden ibarettir. Göl tabanı düz olup 1000 m civarında denizden yüksekte bulunmaktadır. Dik kayalıklar ve çeşitli tiplerde kıyı seddeleri, bunların kıyı kalıntıları olduğunu göstermektedir. Piedmont bölgesi, kısmen bajada ve alluviyal fan ile kaplı neojen kireçtaşı terasları serilerinden meydana gelmiştir. Bajadalarla ilgili olarak en azından iki yığışım devresi tesbit edilebilir. Diğer yandan Konya yakınlarında Sille'de olduğu gibi alluviyal fan'-lardaki aşikâr teraslar (Şekil 2) yığışma sırasındaki değişmeleri izah etmektedir. Bu konuda daha detaylı çalışmaların yapılması tavsiye edilebilir.

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Mixing and perforation of soil by Citellus and Spalax species

T. de Meester

Abstract

Many soil profiles exhibited krotovinas, i.e. fossil or recent burrows, evidently made by *Citellus* and *Spalax* species. With reference to ecological studies by Turkish authors the burrowing activities of both animals are discussed. From a simple test with live animals at Çumra, it was concluded that burrowing rodents have considerably improved soil structure but presumably also caused unduly high losses from unlined irrigation canals in the Çumra Area.

Fig. 1. Young Citellus.

Şekil 1. Genç Citellus'lar

Introduction

During the soil studies in the Great Konya Basin we often noticed many holes and krotovinas (filled holes) about 6 cm diameter in the soil profiles of almost all mapping units, except in wet and saline areas.

Most of the holes are obviously made by the groundsquirrel (Suslik (Russian), Ziesel (German) or tarla sıncapları (Turkish) (Citellus spp.)) which can be seen running everywhere in the Great Konya Basin and whose numerous burrows show their tunneling capacity.

Another burrowing rodent, the blindmouse (molemouse, molerat, sokhor or körfare (Turkish) (Spalax spp.)) also occurs frequently but is less noticed because of its entire subterranean life. Locally both animals cause such a pronounced mixing and perforation of the upper 200 cm of the soil that some study of their activities is desirable.

Recent references on the biology of the east european groundsquirrel are scarce and difficult for access (Karabağ 1953, Tihovinskij 1931–1933). Krotovinas in the soils of the Balkan and Russia are common, often obliterating the AB zonality. Although groundsquirrels are common at present in certain parts of the USA, krotovinas are rare there and occur mainly in the Mollisol region. No soil series are known with horizons obliterated by Citellus spp. (Simonson 1968).

Biological and ecological notes

The information in this Section is derived entirely from Karabağ (1953) and Brehm (1914).

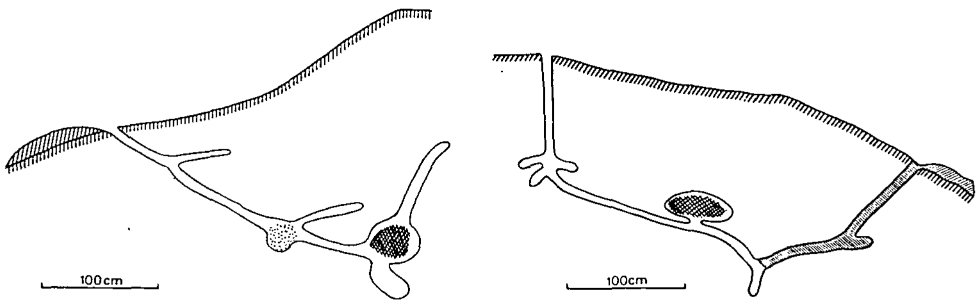
Citellus spp. Although we have not ourselves identified them, the rodents are presumably mainly *Citellus xanthoprymus* Bennet. This species is abundant in Central Anatolia where annual precipitation is between 200–400 mm and seldom in areas with more rainfall. The adult is about 20 cm long without and 25 cm with tail. They are clean attractive animals with large dark eyes (Fig. 1) and make excellent pets in captivity.

Citellus is gregarious but each has its own hole. Even males and females live apart except in the mating season. In summer Citellus is active during daylight mainly at digging, eating and collecting food for winter supplies. Their diet is varied, mainly seeds, seedlings and young sprouts, but also insects, larvae, worms, lizards, frogs, and, quite frequently, each other.

They hibernate from the first week in October until early March, but wake up at intervals to eat and venture out.

The female Citellus drops 3–8 young once a year in April or May. They have numerous predators: foxes, storks, falcons and hawks. Man has also killed Citellus because of its presumed damage to crops and also (in Russia) for its fur and meat, which is reported to be very tasty. Frost and floods may kill many. Because Citellus is an

Fig. 2. Burrows of Citellus. From Karabağ (1953).



Şekil 2. Citellus dalızları (Karabağ 1953'den).

inhabitant of steppe and the uncultivated lands, its numbers have been reduced mainly by the reclamation for agriculture. Thus it will never become a plague in cultivated areas, except if areas are left open, as the höyüks in the Basin, whch are excellent habitats for Citellus.

Burrows and nests The Citellus digs 2 kinds of burrows: shallow (20–60 cm), temporary ones and deep (70–220 cm) permanent burrows. The temporary burrows are made usually quickly in soft soil as shelter in danger or if far from home.

Permanent burrows are of three different shapes: more than half are a single tunnel running almost vertically down about 220 cm, where the nest is. Other types are not vertical and consist of several tunnels with deep and shallow nests (Fig. 2).

Before hibernating, Citellus may seal the original entrance to its burrow and dig a branch almost to the surface through which it can escape in spring or during its occasional forays. Other branches are made for storing winter supplies.

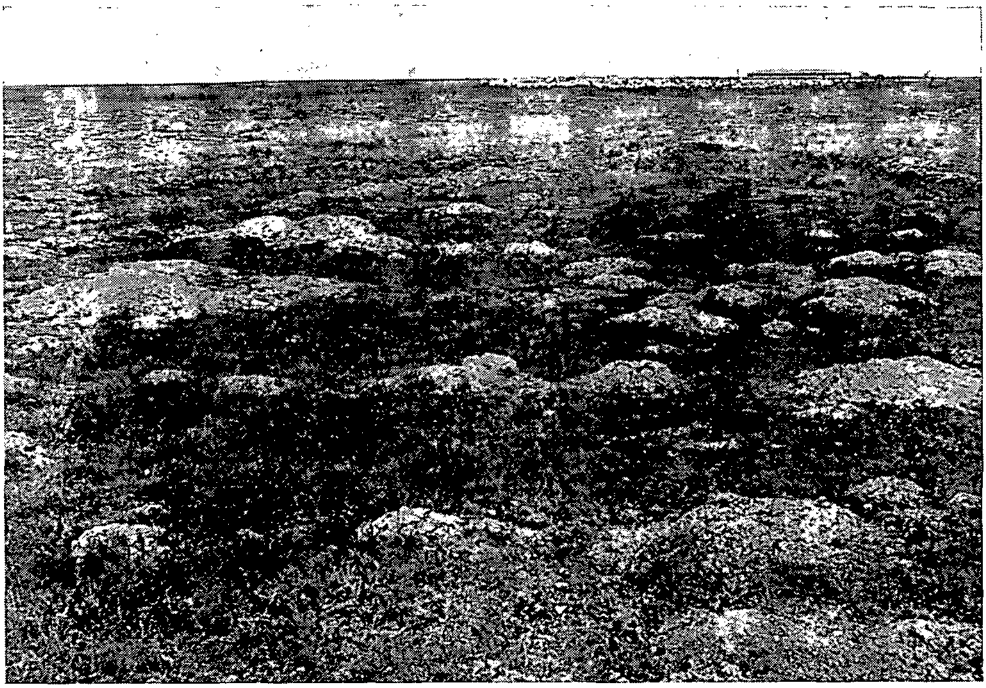
In general Citellus does not heap earth around its burrows but seems to carry the soil away in its mouth to dumps nearby (Fig. 3). Thus Citellus contributes not only to mixing of soil but also to dispersal from place to place.

Spalax species

General The blindmice of the Konya Basin presumably belong to the species *Spalax leucodon* Nordman. They occur in every soil deep and moist enough to support vegetation with roots but not affected by flooding. Although Spalax lives entirely under-ground, it seems frequent in the Basin as can be judged from the big molehills which form a long curving line along its burrow (Fig. 5).

Spalax is about 25 cm long and has no tail (Fig. 4). It is blind because its eyes are covered with skin. It digs with its head, bristly hairs and teeth. The small feet do very little. Spalax feeds on plant roots and seeds, so its habits are very different from the mole (Talpa spp.) with which it is often confused because of its superficial resemblance. Spalax is entirely solitary and mates mainly between January and May. Females bear

Fig. 3. Pasture with earth dumped by Citellus.



Şekil 3. Mer'ada Citellus tarafından atılmış toprak.

3–5 young once a year. Unlike Citellus they do not hibernate but continue burrowing in winter at a deeper level.

The burrows Burrows of Spalax form a complicated system, because the animal digs in all directions: uphill, downhill and even under obstacles like small streams or rocks. A burrow system of one Spalax may extend for 1,5 ha. Such a system, with its nesting rooms was mapped by Mursaloğlu (1955) horizontally and vertically (Fig. 6).

The average depth of burrowing depends mainly on soil moisture and rooting depth of the vegetation. Spalax burrows are therefore more concentrated near the surface than the holes of Citellus.

In winter Spalax may, however, occasionally burrow to 400 cm.

Krotovinas and mixing

Many of the profiles described in Part A have 5–8 cm large krotovinas. During the survey krotovinas were observed in hundreds of pits so that some generalizations are possible. However their distribution was not studied systematically.

Krotovinas occur mainly in well drained loamy or sandy soils, such as Terrace Soils,

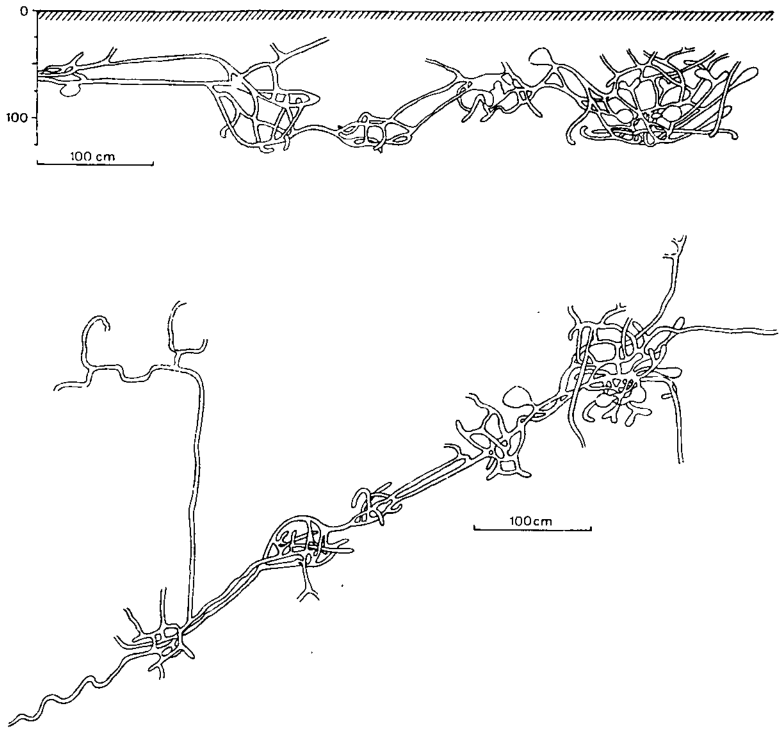
Fig. 4. A Spalax from Rumania at the entrance of its burrow (photo H. Retting from Brehm 1914).

Şekil 4. Romanya'da dalızı önünde duran bir spalax (Foto H. Retting, Brehm 1914 'den).

Fig. 5. Pasture with a long line of Spalax molehills.

Şekil 5. Mer'ada uzun çizgi şeklinde spalax'ın yığdığı toprak kümesi.

Fig. 6. Burrow systems of Spalax (from Mursaloğlu 1955). Above: a section. Below: in plane.



Şekil 6. Spalax'ın dalız sistemi (Mursaloğlu 1955'den). A. bir kesit ve. B. düzlemde.

Colluvial Soils, Bajada Soils, Alluvial Soils, Sandplain Soils and the better drained Marl Soils.

Krotovinas occur mainly between 40 and 100 cm (Fig. 7). Presumably this zone is below the average depth to which frost penetrates.

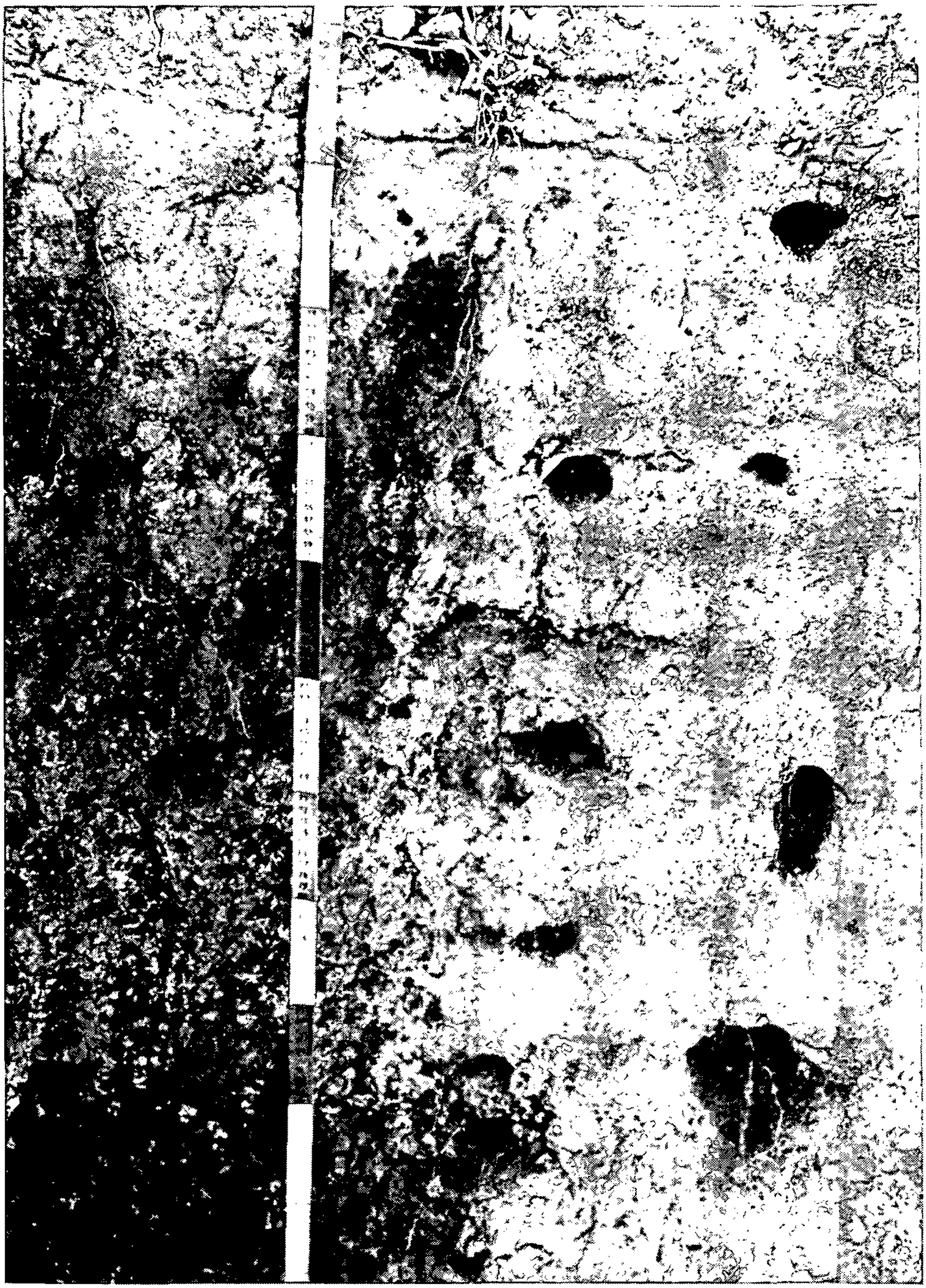
In the field Krotovinas caused by Citellus could not be clearly distinguished from those caused by Spalax. However, it is presumed that the oval and deep ones will be mainly due to Citellus (vertical burrows) and the round and shallow ones mainly to Spalax (horizontal burrows).

Most krotovinas are filled with extraneous soil material from shallower and deeper horizons (Fig. 8). There are many more filled old burrows than open fresh burrows.

Krotovinas in calcic horizons or in horizons with a blocky or prismatic structure always contain soil material with a subangular (= good) structure (Fig. 9). Hence roots tend to follow krotovinas in horizons or soils with 'bad' structure (Fig. 10).

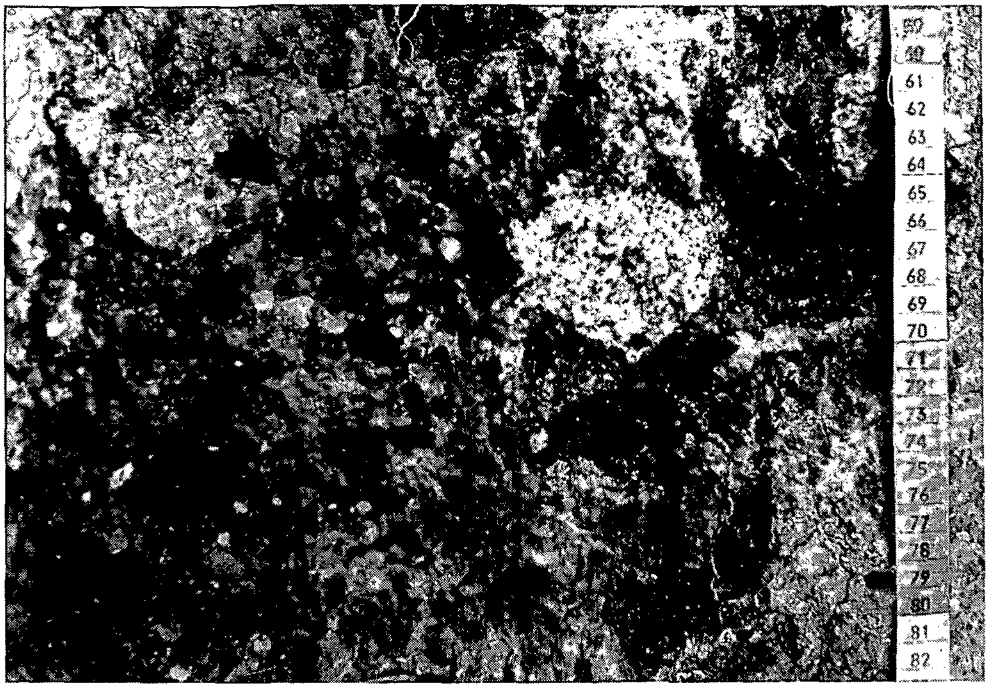
The difference in structure of krotovinas must contribute substantially to the infiltration rate and permeability. We think that the unlined open irrigation canals in the Basin loose so much water because of the former activities of Citellus and Spalax.

Fig. 7. Terrace Soil (TeA) profile showing krotovinas and old burrows especially between 40 and 100 cm.



Şekil 7. Bilhassa 40–100 cm ler arasında krotovinalar ve eski dalızları gösteren teras toprağı (TeA) profili.

Fig. 8. Volcanic Bajada Soil (BvA) showing krotovinas filled with white marl from subsoil. Smaller white spots are carbonates.



Şekil 8. Alt topraktan taşınan beyaz marn ile doldurulmuş beyaz krotovinaları gösteren volkanik bajada toprağı (BvA). Daha küçük beyaz noktalar karbonatlardır.

An experiment

In 1965 a simple experiment was set up to study the mixing of soil by Citellus. A cage of fine-mesh wire on a steel frame 100 × 100 × 200 cm was buried 150 cm into well drained alluvial soil near Çumra. The underground part of the cage was filled with alternating layers of brown loam and white soft lime.

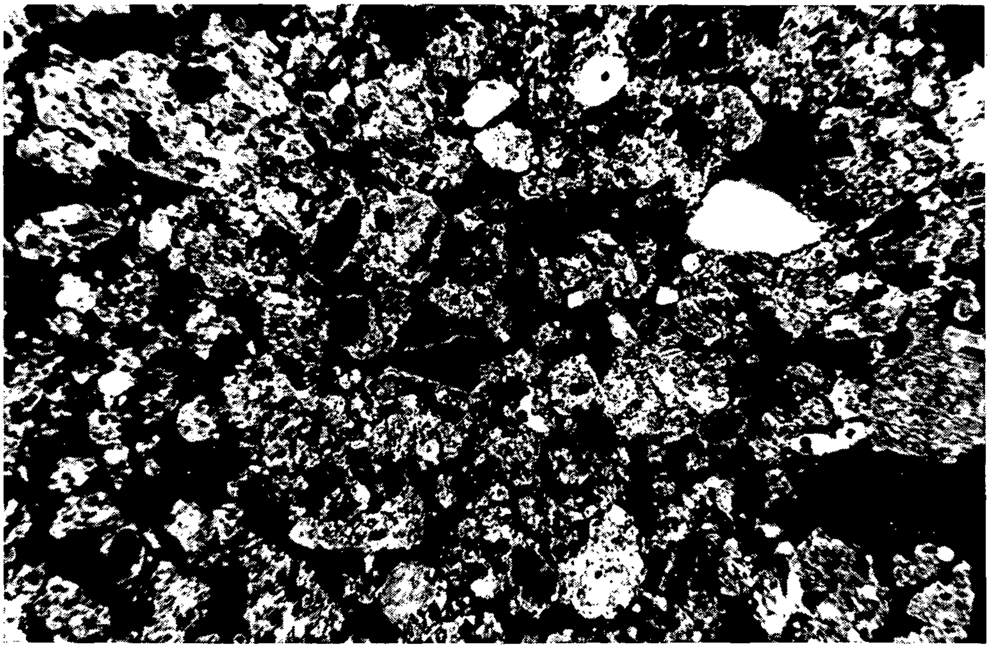
Two ground squirrels and for a short period a blindmouse were put in the cage and allowed to dig freely.

They lived in the cage for 3 months before hibernating. Ample wheat was supplied for the winter.

When the site was dug up next spring, the animals had disappeared but the layers had been entirely mixed.

This expected result merely confirms the enormous capacity of Citellus to dig and to move soil.

Fig. 9. Section of the B-horizon of a Terrace Soil (TeA). Above: Outside a krotovina. Below: inside a krotovina (magnification × 20).



Şekil 9. Teras toprağının (TeA) B-horizonunun kesiti.
A. krotovina dışında. B. krotovinanın içinde (yaklaşık büyütme 20 ×).

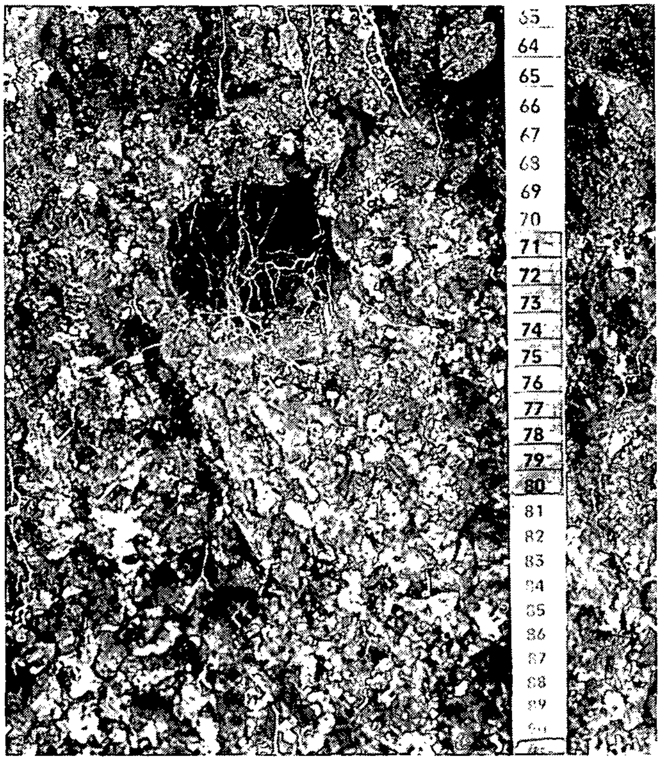


Fig. 10. Limestone Bajada Soil (BvA) showing concentration of roots in a krotovina from which the soil has been removed.

Şekil 10. Kireçtaşı Bajada Toprağunda (BvA) ki bir krotovinada yer değiştirmiş, toprakta köklerin yoğunlaşması.

Conclusion

As the soils of the Great Konya Basin have predominantly an angular blocky or prismatic structure and as hard and dense calcic horizons are common and coincide in depth with the krotovina zone, the activity of Citellus and Spalax in past and present has improved soil suitability for agriculture: structure is improved, layers are mixed and the soil becomes more aerated.

A well drained soil contains on average about 4 vertical and 2 horizontal fossil and fresh krotovinas per square metre between 40–100 cm. If their diameter is about 7 cm, about 945 cubic metres soil has been shifted per hectare.

Possible negative effects because of crop damage and loss of irrigation water cannot be judged.

Özet

Toprak profillerinin önemli bir kısmında, aşikâr olarak *Citellus* ve *Spalax* türleri tarafindan yapılan pek çok krotovina oluşukları, yani yeni, veya eski *Rodent* dalızları görülmektedir. Türk ilim adamları tarafindan yapılan ekolojik çalışmalar hakkındaki araştırmalarada dayanarak her iki çeşit hayvanlar tarafından dalızların yapılması üzerinde durulmuştur. Çumra'da canlı hayvanlarla yapılan basit deneylerden de anlaşıldığı gibi *Rodent*' lerin eski ve yeni dalız yapma çalışmaları göz önüne alınacak derecede toprak verimliliğini geliştirdiği, fakat aynı zamanda Çumra bölgesinde toprak sulama kanallarından (çimento v.s. ile kaplı olmayan) son derece fazla su kaybına sebep olduklarının zannedildiği, tesbit edilmiştir.

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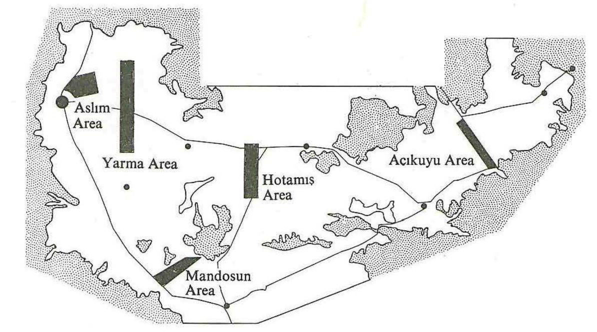
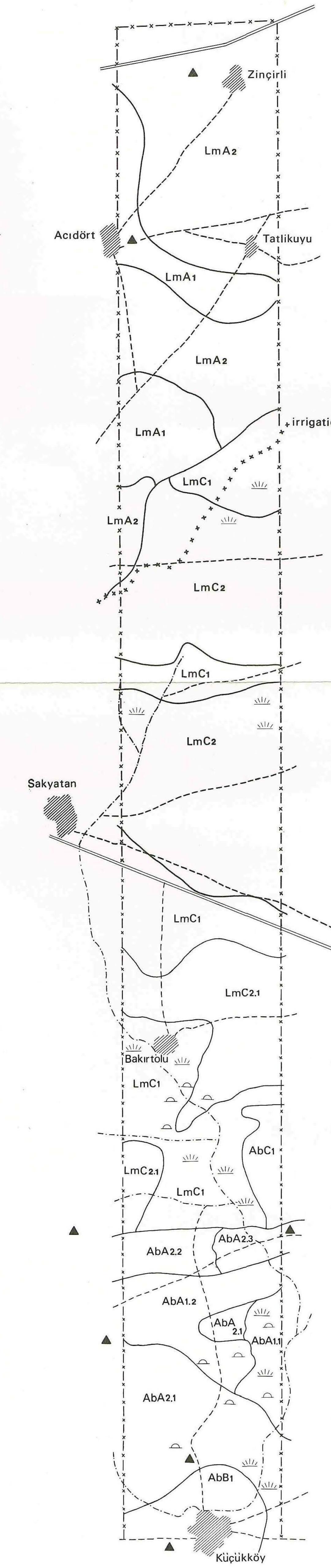
SOIL MAPS OF SAMPLE AREAS
ÖRNEK SAHALARIN TOPRAK HARİTALARI

Survey 1964–1968
Toprak etüd ve haritalama 1964–1968

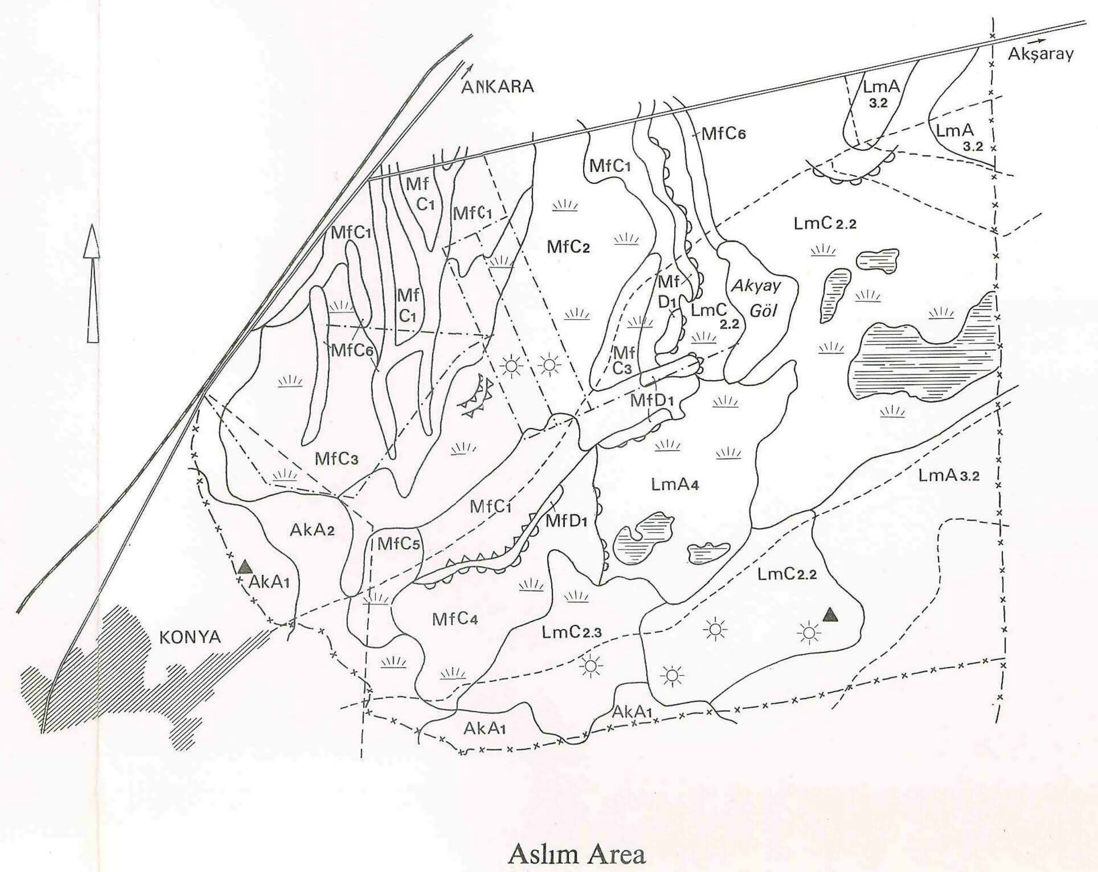
Scale Ölçek 1:100,000

Appendix 2 to report: The Soils of the Great Konya Basin
Büyük Konya Havzasinin toprak etudüne ek (2)

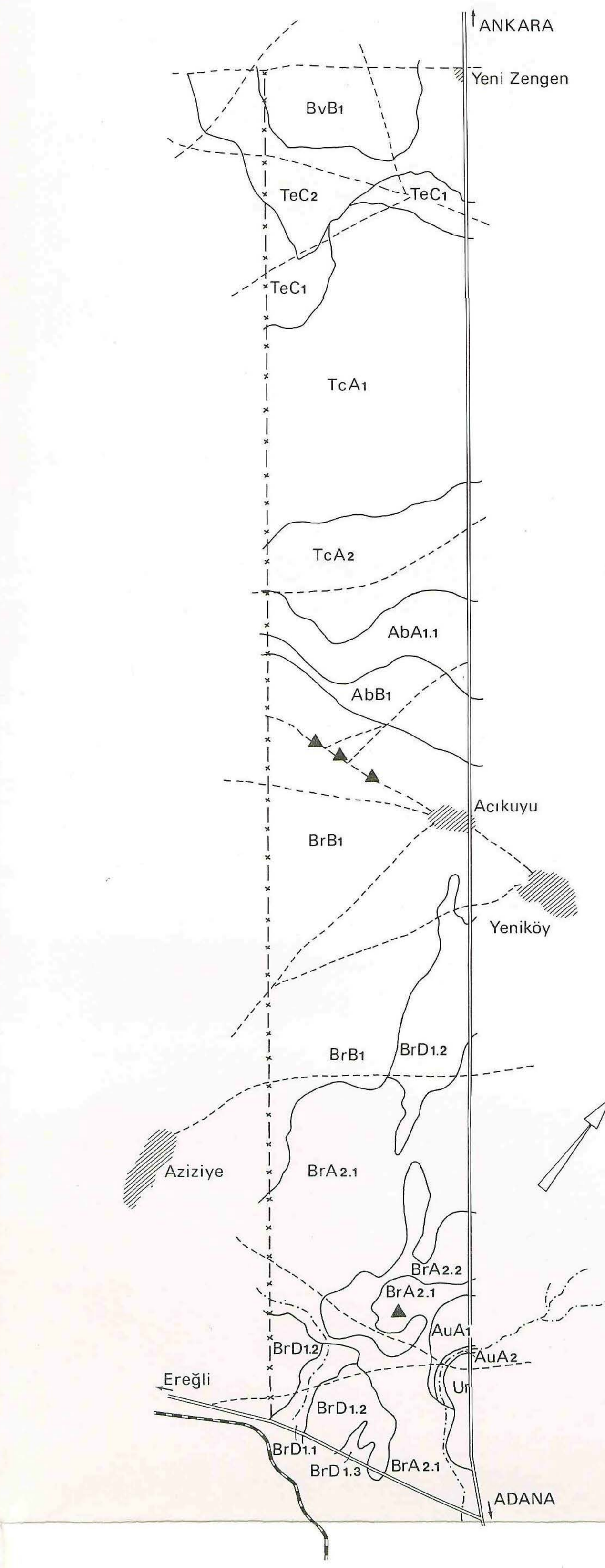




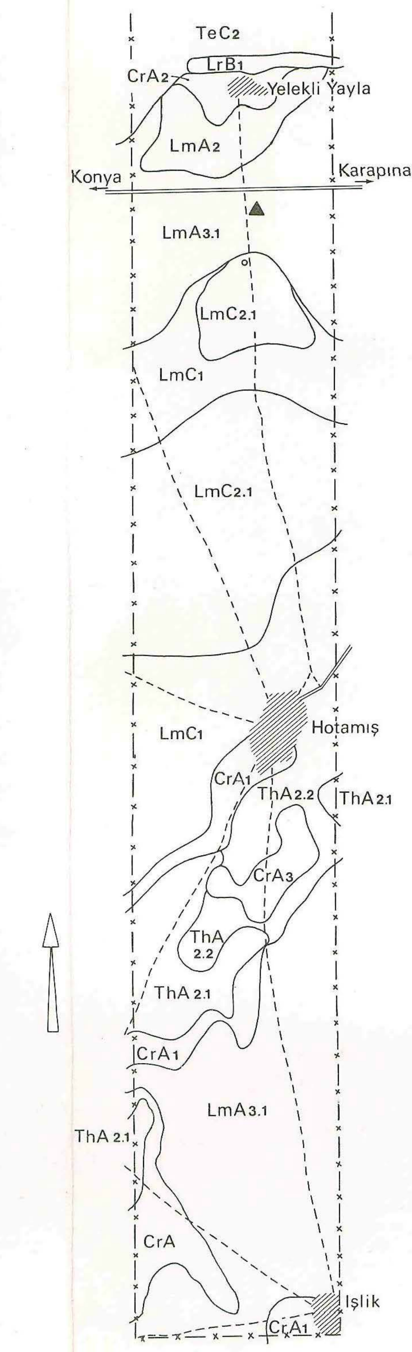
Yarma Area



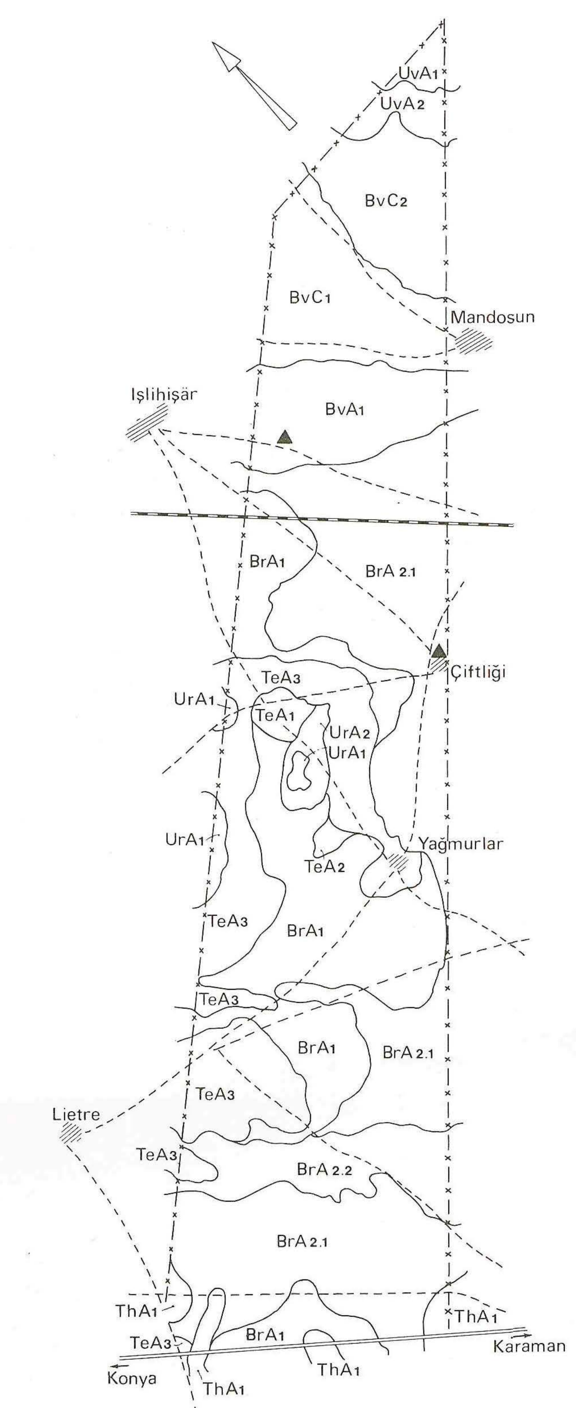
Aslım Area



Acıkuyu Area



Hotamış Area



Mandosun Area

LEGEND/LEJANT

With reference to the Soil Map, Appendix 1
Toprak haritasına baglı olarak ek 1

Ur LIMESTONE UPLAND SOILS
KİREÇ TAŞI YÜKSEK ARAZİ TOPRAKLARI

UrA *Shallow angular-cobbly loamy or rocky*
Sığ, köşeli taşlı tınlı veya kayalık

- UrA1 Denuded limestone
  Aşınmış kireçtaşı
- UrA2 Shallow loam over limestone
  Kireç taşı üzerinde sığ tın

Uv VOLCANIC UPLAND SOILS
VOLKANİK YÜKSEK ARAZİ TOPRAKLARI

UvA *Angular-cobbly pumice and ash, or rocky*
Köşeli taşlı sünger taşı ve volkanik kül, veya kayalık

- UvA1 Denuded volcanic rock
  Aşınmış, volkanik taş
- UvA2 Shallow loamy ash over volcanic rock
  Volkanik taş üzerinde sığ tınlı volkan külü

Cr LIMESTONE COLLUVIAL SOILS
KİREÇ TAŞI KOLLUVİYAL TOPRAKLARI

CrA *Angular-cobbly, moderately deep sandy or loamy*
Köşeli taşlı, orta dik meyil (% 10–30) kumlu veya tınlı

- CrA1 Deep, brown gravelly sandy loam
  Derin, kahverengi çakıllı kumlu tın
- CrA2 Deep, pale-brown loam
  Derin, soluk kahverengi tın
- CrA3 Moderately deep sandy loam with shell fragments
  Fosil parçalarını ihtiva eden orta derin kumlu tın

Te FLAT TERRACE SOILS
DÜZ TERAS TOPRAKLARI

TeA *Loamy or clayey, soft lime subsurface soil over limestone*
Tınlı veya killi (kireç taşı üzerinde yumuşak kireç alt topraklı)

- TeA1 Very shallow or shallow loam over a petrocalcic horizon
  Bir petrokalsik horizon üzerinde çok sığ veya sığ tın
- TeA2 Very shallow or shallow loam over a soft calcic horizon
  Bir yumuşak kalsik horizon üzerinde çok sığ veya sığ tın
- TeA3 Deep or very deep loam over soft lime
  Yumuşak kireç üzerinde derin veya çok derin tın

TeC *Eroded loamy or clayey, locally stony or shallow over limestone*
Erozyona uğramış tınlı veya killi, yer yer taşlı veya sığ

- TeC1 Shallow loamy over limestone
  Kireç taşı üzerinde sığ tın
- TeC2 Moderately deep loam over limestone
  Kireç taşı üzerinde orta derin tın

Th UNDULATING TERRACE SOILS
ONDÜLELİ TERAS TOPRAKLARI

ThA *Angular-cobbly clayey, locally very shallow over limestone*
Köşeli taşlı yer yer çok sığ killi kireç taşı üzerinde

- ThA1 Shallow angular-cobbly clay over limestone
  Kireç taşı üzerinde sığ köşeli taşlı kil
- ThA2.1 Moderately deep angular cobbly loam, high phase
  Orta derin köşeli taşlı tın, yüksek fazı
- ThA2.2 As above, low phase
  Yukarıdaki, gibi alçak fazı

Tc SOFT LIME SOILS
YUMUŞAK KİREÇLİ TOPRAKLAR

TcA *Locally very shallow loamy or clayey over soft lime*
Yer yer çok sığ tınlı veya killi yumuşak kireç üzerinde

- TcA1 Shallow brown clay-loam
  Sığ kahverengi killi-tın
- TcA2 Shallow grayish-brown clay-loam
  Sığ grimsi-kahverengi killi-tın

Br LIMESTONE BAJADA SOILS
KİREÇ TAŞI BAJADA TOPRAKLARI

BrA *Predominantly reddish-brown clayey*
Killi, genellikle kırmızımsı kahverengi

- BrA1 Moderately deep clay-loam
  Orta derin killi-tın
- BrA2.1 Deep or very deep clay-loam
  Derin veya çok derin killi-tın
- BrA2.2 Deep or very deep heavy clay
  Derin veya çok derin ağır kil

BrB *Predominantly brown loamy or clayey*
Tınlı veya killi, genellikle kahverengi

- BrB1 Deep or very deep loam or clay-loam with gravel
  Çakıllı derin veya çok derin tın veya killi-tın

BrD *Dissected gravelly clayey*
Bölünmüş ve erozyona uğramış çakıllı kil

- BrD1.1 Deep loam
  Derin tın
- BrD1.2 Deep stony loam
  Derin taşlı tın
- BrD1.3 Shallow stony loam over a petrocalcic horizon
  Bir petrokalsik horizon üzerinde sığ taşlı tın

Bv VOLCANIC BAJADA SOILS
VOLKANİK BAJADA TOPRAKLARI

BvA *Locally vertic clayey*
Yer yer vertik karekterli killi

- BvA1 Moderately deep or deep heavy clay
  Orta derin veya derin ağır kil

BvB *Gravelly sandy or loamy, locally with a duripan*
Çakıllı kumlu veya tınlı, yer yer duripanlı

- BvB1 Deep or very deep brown loamy sand
  Derin veya çok derin kahverengi tınlı kum

BvC *Sloping angular-cobbly sandy or loamy*
Köşeli taşlı kumlu veya tınlı, meyilli (% 5–16)

- BvC1 Very deep gravelly loam
  Çok derin çakıllı tın
- BvC2 Very deep gravelly or stony sand
  Çok derin çakıllı veya taşlı kum

Ab FORMER BACKSWAMP SOILS
ESKİ BATAKLIK ARDI TOPRAKLARI

AbA *Predominantly grayish swelling clay*
Fazla şişen killi topraklar, ekseriyetle grimsi

- AbA1.1 Shallow to moderately deep over marl
  Marn üzerinde sığ, orta derin
- AbA1.2 Moderately deep to deep over marl
  Marn üzerinde orta-derin, derin
- AbA2.1 Deep over marl
  Marn üzerinde derin
- AbA2.2 Very deep over marl
  Marn üzerinde çok derin
- AbA2.3 as AbA2.2, but less heavy clay
  AbA2.2 gibi, fakat daha az ağır killi

AbB *Predominantly brownish swelling clay*
Fazla şişen killi topraklar, ekseriyetle kahverengimsi

- AbB1 Deep and very deep brown clay
  Derin ve çok derin kahverengi kil

AbC *Mainly shallow non-swelling clayey or loamy over soft lime or marl*
Şişmeyen killi veya tınlı, ekseriya orta derin yumuşak kireç veya marn üzerinde

- AbC1 Shallow to moderately deep over marl
  Marn üzerinde sığ, orta derin

Ak MERAM AND SİLLE FAN SOILS
MERAM VE SİLLE NEHRİ YELPAZESİ TOPRAKLARI

AkA *Clayey*
Killi

- AkA1 Brown clay with sandy layers, well drained
  Kumlu katları, ihtiva eden kahverengi kil, iyi drenajlı
- AkA2 Gray-brown gypsiferous clay, poorly drained
  Gri-kahverenkli jipsli kil, zayıf drenajlı

Au SOILS OF MEDIUM SIZED FANS
ORTA BÜYÜKLÜKTE NEHİR YELPAZESİ TOPRAKLARI

AuA *Clayey and loamy*
Killi veya tınlı

- AuA1 Loamy
  Tınlı
- AuA2 Stony loam
  Taşlı tın

Lm MARL SOILS
MARN TOPRAKLARI

LmA *Clayey with shell fragnents*
Killi, fosil parçacıklarnı havi olanlar

- LmA1 Shallow light-brown surface soil
  Sığ açık kahverenkli yüzey toprak
- LmA2 Moderately deep light-brown surface soil
  Orta derin açık kahverenkli yüzey toprak
- LmA3.1 Grayish brown surface soil
  Grimsi-kahverengi yüzey toprak
- LmA3.2 As above and very gypsiferous
  Yukarıdaki gibi ve çok jipsli
- LmA4 Loamy, very dark-brown surface soil, gypsiferous and poorly drained
  Tınlı, çok koyu kahverenkli yüzey toprak, jipsli ve zayıf drenajlı

LmC *Clayey with shell fragments, dark-gray organic surface soil*
LmA nın aynı, sığ koyu gri organik yüzey topraklı

- LmC1 Shallow dark-gray surface soil, gypsiferous and marshy
  Sığ koyu gri yüzey toprak, jipsli ve bataklıklı
- LmC2.1 Moderately deep dark-gray surface soil
  Orta derin koyu gri yüzey toprak
- LmC2.2 as LmC 2.1 and gypsiferous
  LmC 2.1 gibi ve jipsli
- LmC2.3 as LmC 2.2 but over black organic subsurface layer
  LmC 2.2 gibi, fakat siyah organik yüzey altı katı üzerinde
- LmC3 Deep dark-gray surface soil
  Derin koyu gri yüzey toprak

Lr SANDRIDGE SOILS
GÖL KENARI TOPRAKLARI

LrB *Low*
Alçak

- B1 Gravelly sand
  Çakıllı kum

Mf MARSH SOILS
BATAKLIK TOPRAKLARI

MfC *Granular and crusted calcareous tufa*
Yumuşak ve küçük parçalara ayrılmış kalkerli tufa

- MfC1 Moderately deep brown loam over calcareous hardpan
  Kalkerli sert pan üzerinde orta derin kahverenkli tın
- MfC2 Shallow dark-gray loam over soft limey pseudosand; locally calcareous crusts in subsoil
  Yumuşak kireçli yalancı kum üzerinde sığ koyu-gri tın alt toprakta yer yer kalker kabukları
- MfC3 Complex of MfC1 and MfC2 (depressions)
  MfC1 ve MfC2 kompleksi (çukur yerlerde)
- MfC4 Moderately deep pale-brown loam over black organic subsurface layers; carbonatic clay in subsoil
  Siyah organik yüzey altı katları üzerinde orta derin soluk kahverenkli tın, alt toprakta karbonatlı kil
- MfC5 Shallow brown clay over soft limey pseudosand without hardpans or crusts
  Sert pansiz veya kabuksız yumuşak kireçli yalancı kum üzerinde sığ kahverengi kil
- MfC6 Creeks with soils as MfC2 with or without black organic surface soil
  Siyah organik yüzey toprağı ihtiva eden ve etmeyen MfC2 gibi toprakları ihtiva eden dereler

MfD *Soft gypsum*
Yumuşak jips

- MfD1 Moderately deep, pale-brown surface soil
  Orta derin, soluk kahverenkli yüzey toprak

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Scale Ölçek 1:100,000

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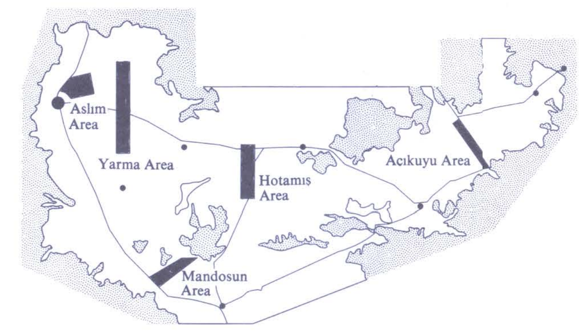
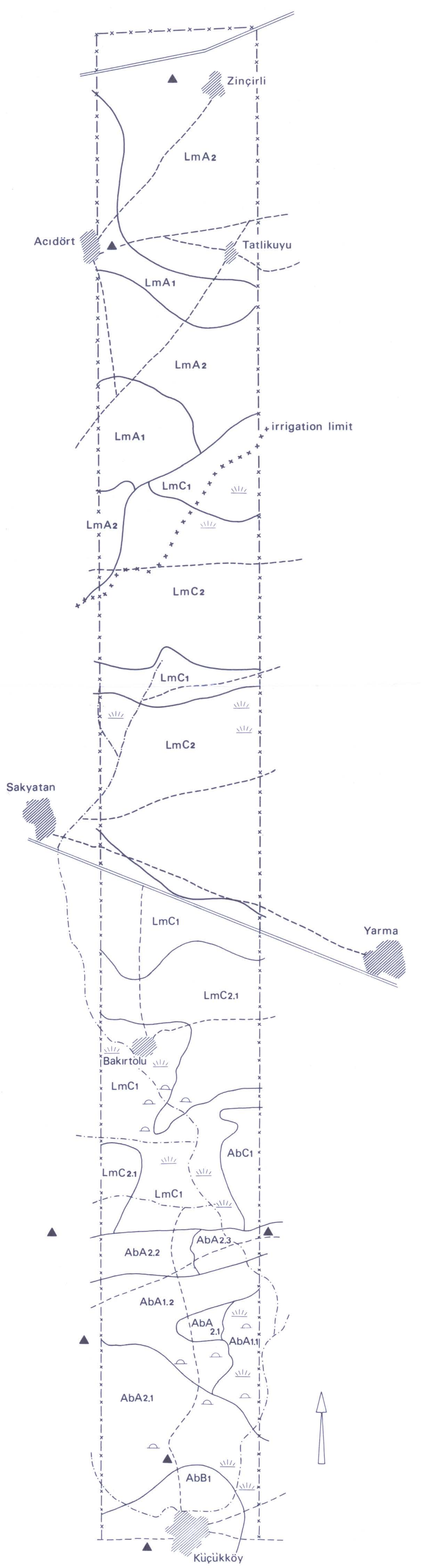
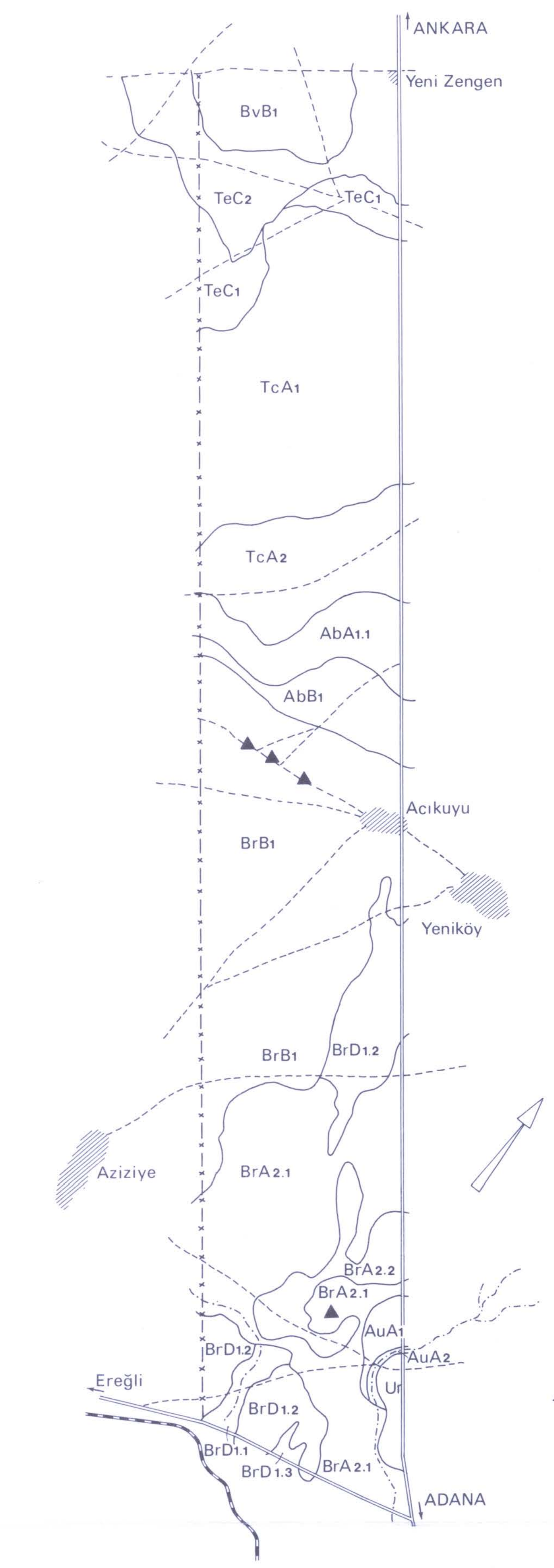
Büyük Konya Havzainin toprak etudüne ek (2)





Yarma Area

Aslım Area



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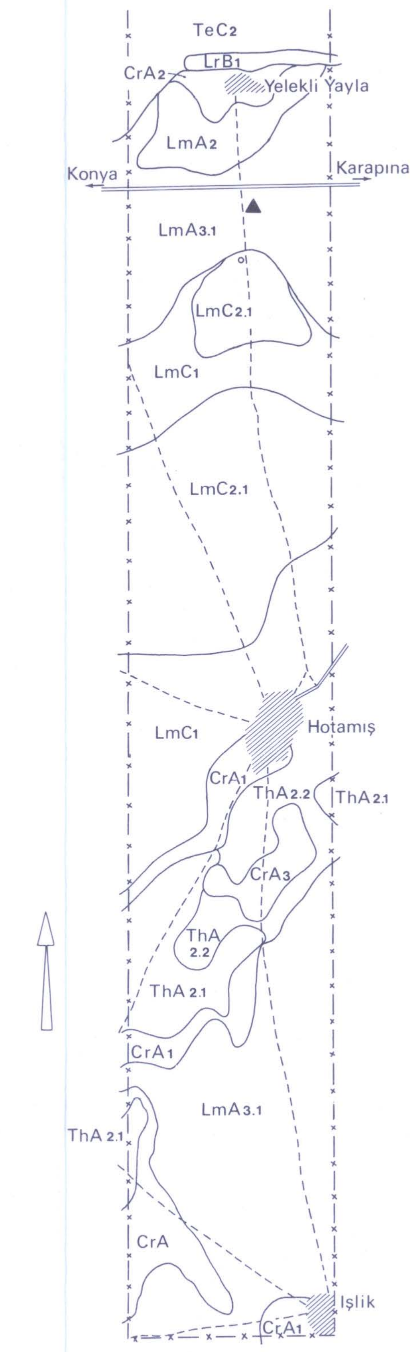
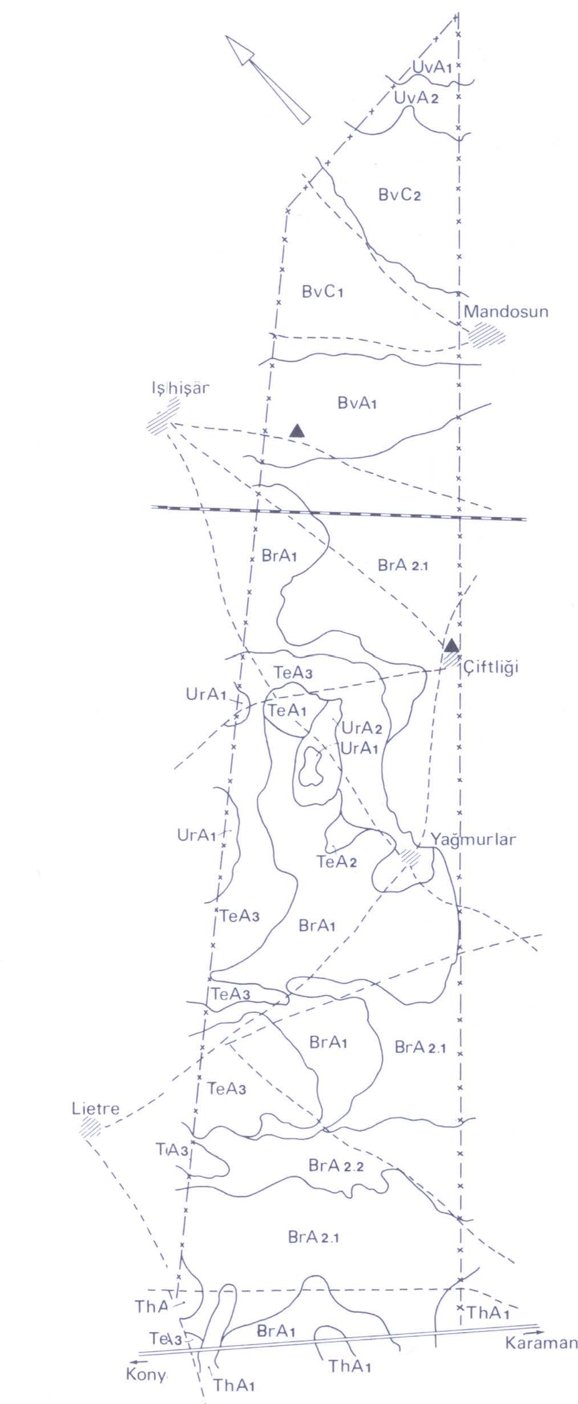


Hotamış Area



Mandosun Area

LEGEND/LEJANT

With reference to the Soil Map, Appendix 1
Toprak haritasına baglı olarak ek 1

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Sığ, köşeli taşlı tınlı veya kayalık

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- UrA2 Shallow loam over limestone
  Kireç taşı üzerinde sığ tın

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VOLKANİK YÜKSEK ARAZİ TOPRAKLARI

UvA *Angular-cobbly pumice and ash, or rocky*
Köşeli taşlı sünger taşı ve volkanik kül, veya kayalık

- UvA1 Denuded volcanic rock
  Aşınmış, volkanik taş
- UvA2 Shallow loamy ash over volcanic rock
  Volkanik taş üzerinde sığ tınlı volkan külü

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  Fosil parçalarını ihtiva eden orta derin kumlu tın

Te FLAT TERRACE SOILS
DÜZ TERAS TOPRAKLARI

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Tınlı veya killi (kireç taşı üzerinde yumuşak kireç alt topraklı)

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  Bir yumuşak kalsik horizon üzerinde çok sığ veya sığ tın
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  Yumuşak kireç üzerinde derin veya çok derin tın

TeC *Eroded loamy or clayey, locally stony or shallow over limestone*
Erozyona uğramış tınlı veya killi, yer yer taşlı veya sığ

- TeC1 Shallow loamy over limestone
  Kireç taşı üzerinde sığ tın
- TeC2 Moderately deep loam over limestone
  Kireç taşı üzerinde orta derin tın

Th UNDULATING TERRACE SOILS
ONDÜLELİ TERAS TOPRAKLARI

ThA *Angular-cobbly clayey, locally very shallow over limestone*
Köşeli taşlı yer yer çok sığ killi kireç taşı üzerinde

- ThA1 Shallow angular-cobbly clay over limestone
  Kireç taşı üzerinde sığ köşeli taşlı kil
- ThA2.1 Moderately deep angular cobbly loam, high phase
  Orta derin köşeli taşlı tın, yüksek fazı
- ThA2.2 As above, low phase
  Yukarıdaki, gibi alçak fazı

Tc SOFT LIME SOILS
YUMUŞAK KİREÇLİ TOPRAKLAR

TcA *Locally very shallow loamy or clayey over soft lime*
Yer yer çok sığ tınlı veya killi yumuşak kireç üzerinde

- TcA1 Shallow brown clay-loam
  Sığ kahverengi killi-tın
- TcA2 Shallow grayish-brown clay-loam
  Sığ grimsi-kahverengi killi-tın

Br LIMESTONE BAJADA SOILS
KİREÇ TAŞI BAJADA TOPRAKLARI

BrA *Predominantly reddish-brown clayey*
Killi, genellikle kırmızımsı kahverengi

- BrA1 Moderately deep clay-loam
  Orta derin killi-tın
- BrA2.1 Deep or very deep clay-loam
  Derin veya çok derin killi-tın
- BrA2.2 Deep or very deep heavy clay
  Derin veya çok derin ağır kil

BrB *Predominantly brown loamy or clayey*
Tınlı veya killi, genellikle kahverengi

- BrB1 Deep or very deep loam or clay-loam with gravel
  Çakıllı derin veya çok derin tın veya killi-tın

BrD *Dissected gravelly clayey*
Bölünmüş ve erozyona uğramış çakıllı kil

- BrD1.1 Deep loam
  Derin tın
- BrD1.2 Deep stony loam
  Derin taşlı tın
- BrD1.3 Shallow stony loam over a petrocalcic horizon
  Bir petrokalsik horizon üzerinde sığ taşlı tın

Bv VOLCANIC BAJADA SOILS
VOLKANİK BAJADA TOPRAKLARI

BvA *Locally vertic clayey*
Yer yer vertik karekterli killi

- BvA1 Moderately deep or deep heavy clay
  Orta derin veya derin ağır kil

BvB *Gravelly sandy or loamy, locally with a duripan*
Çakıllı kumlu veya tınlı, yer yer duripanlı

- BvB1 Deep or very deep brown loamy sand
  Derin veya çok derin kahverengi tınlı kum

BvC *Sloping angular-cobbly sandy or loamy*
Köşeli taşlı kumlu veya tınlı, meyilli (% 5–16)

- BvC1 Very deep gravelly loam
  Çok derin çakıllı tın
- BvC2 Very deep gravelly or stony sand
  Çok derin çakıllı veya taşlı kum

Ab FORMER BACKSWAMP SOILS
ESKİ BATAKLIK ARDI TOPRAKLARI

AbA *Predominantly grayish swelling clay*
Fazla şişen killi topraklar, ekseriyetle grimsi

- AbA1.1 Shallow to moderately deep over marl
  Marn üzerinde sığ, orta derin
- AbA1.2 Moderately deep to deep over marl
  Marn üzerinde orta-derin, derin
- AbA2.1 Deep over marl
  Marn üzerinde derin
- AbA2.2 Very deep over marl
  Marn üzerinde çok derin
- AbA2.3 as AbA2.2, but less heavy clay
  AbA2.2 gibi, fakat daha az ağır killi

AbB *Predominantly brownish swelling clay*
Fazla şişen killi topraklar, ekseriyetle kahverengimsi

- AbB1 Deep and very deep brown clay
  Derin ve çok derin kahverengi kil

AbC *Mainly shallow non-swelling clayey or loamy over soft lime or marl*
Şişmeyen killi veya tınlı, ekseriya orta derin yumuşak kireç veya marn üzerinde

- AbC1 Shallow to moderately deep over marl
  Marn üzerinde sığ, orta derin

Ak MERAM AND SİLLE FAN SOILS
MERAM VE SİLLE NEHRİ YELPAZESİ TOPRAKLARI

AkA *Clayey*
Killi

- AkA1 Brown clay with sandy layers, well drained
  Kumlu katları, ihtiva eden kahverengi kil, iyi drenajlı
- AkA2 Gray-brown gypsiferous clay, poorly drained
  Gri-kahverenkli jipsli kil, zayıf drenajlı

Au SOILS OF MEDIUM SIZED FANS
ORTA BÜYÜKLÜKTE NEHİR YELPAZESİ TOPRAKLARI

AuA *Clayey and loamy*
Killi veya tınlı

- AuA1 Loamy
  Tınlı
- AuA2 Stony loam
  Taşlı tın

Lm MARL SOILS
MARN TOPRAKLARI

LmA *Clayey with shell fragments*
Killi, fosil parçacıklarını havi olanlar

- LmA1 Shallow light-brown surface soil
  Sığ açık kahverenkli yüzey toprak
- LmA2 Moderately deep light-brown surface soil
  Orta derin açık kahverenkli yüzey toprak
- LmA3.1 Grayish brown surface soil
  Grimsi-kahverengi yüzey toprak
- LmA3.2 As above and very gypsiferous
  Yukarıdaki gibi ve çok jipsli
- LmA4 Loamy, very dark-brown surface soil, gypsiferous and poorly drained
  Tınlı, çok koyu kahverenkli yüzey toprak, jipsli ve zayıf drenajlı

LmC *Clayey with shell fragments, dark-gray organic surface soil*
LmA nın aynı, sığ koyu gri organik yüzey topraklı

- LmC1 Shallow dark-gray surface soil, gypsiferous and marshy
  Sığ koyu gri yüzey toprak, jipsli ve bataklıklı
- LmC2.1 Moderately deep dark-gray surface soil
  Orta derin koyu gri yüzey toprak
- LmC2.2 as LmC 2.1 and gypsiferous
  LmC 2.1 gibi ve jipsli
- LmC2.3 as LmC 2.2 but over black organic subsurface layer
  LmC 2.2 gibi, fakat siyah organik yüzey altı katı üzerinde
- LmC3 Deep dark-gray surface soil
  Derin koyu gri yüzey toprak

Lr SANDRIDGE SOILS
GÖL KENARI TOPRAKLARI

LrB *Low*
Alçak

- B1 Gravelly sand
  Çakıllı kum

Mf MARSH SOILS
BATAKLIK TOPRAKLARI

MfC *Granular and crusted calcareous tufa*
Yumuşak ve küçük parçalara ayrılmış kalkerli tufa

- MfC1 Moderately deep brown loam over calcareous hardpan
  Kalkerli sert pan üzerinde orta derin kahverenkli tın
- MfC2 Shallow dark-gray loam over soft limey pseudosand; locally calcareous crusts in subsoil
  Yumuşak kireçli yalancı kum üzerinde sığ koyu-gri tın alt toprakta yer yer kalker kabukları
- MfC3 Complex of MfC1 and MfC2 depressions)
  MfC1 ve MfC2 kompleksi (çukur yerlerde)
- MfC4 Moderately deep pale-brown loam over black organic subsurface layers; carbonatic clay in subsoil
  Siyah organik yüzey altı katları üzerinde orta derin soluk kahverenkli tın, alt toprakta karbonatlı kil
- MfC5 Shallow brown clay over soft limey pseudosand without hardpans or crusts
  Sert pansiz veya kabuksız yumuşak kireçli yalancı kum üzerinde sığ kahverengi kil
- MfC6 Creeks with soils as MfC2 with or without black organic surface soil
  Siyah organik yüzey toprağı ihtiva eden ve etmeyen MfC2 gibi toprakları ihtiva eden dereler

MfD *Soft gypsum*
Yumuşak jips

- MfD1 Moderately deep, pale-brown surface soil
  Orta derin, soluk kahverenkli yüzey toprak

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