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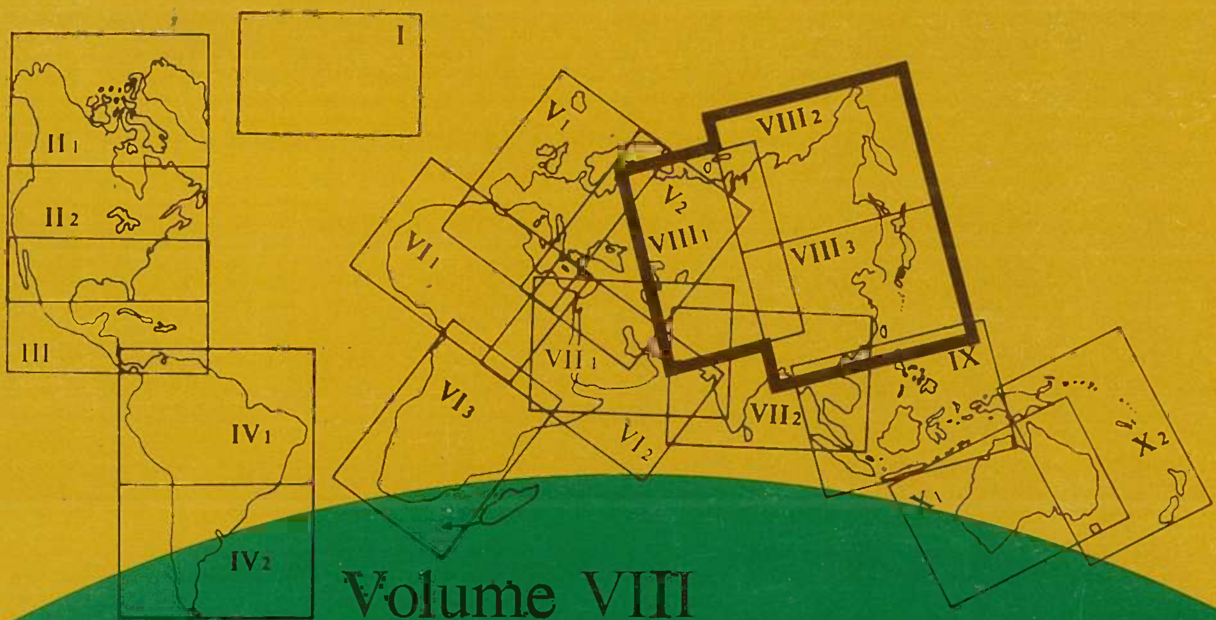
Soil map of the world

1:5 000 000



Volume VIII
North and Central Asia

Unesco

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Soil map of the world

1 : 5 000 000

Volume VIII

North and Central Asia

FAO - Unesco
Soil map of the world

Volume I	Legend
Volume II	North America
Volume III	Mexico and Central America
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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

FAO - Unesco

Soil map of the world

1 : 5 000 000

Volume VIII
North and Central Asia

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PREFACE

The project for a joint FAO/Unesco Soil Map of the World was undertaken following a recommendation of the International Society of Soil Science. It is the first attempt to prepare, on the basis of international cooperation, a soil map covering all the continents of the world in a uniform legend, thus enabling the correlation of soil units and comparisons on a global scale. The project, which started in 1961, fills a gap in present knowledge of soil potentialities throughout the world and provides a useful instrument in planning agricultural and economic development programmes.

The project has been carried out under the scientific authority of an international advisory panel, within the framework of FAO and Unesco programmes. The different stages of the work included comparative studies of soil maps, field and laboratory work, and the organization of international expert meetings and study tours. The secretariat of the joint project, located at FAO Headquarters, was vested with the responsibility of compiling the technical information, correlating the studies and drafting the final maps and text. FAO and Unesco shared the expenses involved in the realization of the project, and Unesco undertook publication of its results.

The present volume, covering the soils of North and Central Asia, is the eighth of a set of ten which make up the complete publication of the Soil Map of the World. The first volume records introductory information and presents the definitions of the elements of the legend which is used uniformly throughout the publication. Each of the nine following volumes comprises an explanatory text and the corresponding map sheets covering the main regions of the world.

FAO and Unesco wish to express their gratitude to the government institutions, the International Society of Soil Science and the many individual soil scientists who have contributed so much to this international project.

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SUMMARY

This volume describes the North and Central Asian section of the 1 : 5 000 000 Soil Map of the World. The compilation of the Soil Map of North and Central Asia was accomplished by FAO and Unesco in a joint project initiated in 1961 in close cooperation with the government institutions concerned.

The maps

The map sheets which make up the Soil Map of North and Central Asia are drawn on topographic base maps of the 1 : 5 000 000 series of the American Geographical Society. The map units are associations of soil units divided into texture and slope classes. They are marked on the maps by symbols. Dominant soils are shown by colours and phases are shown by overprints.

A small inset map shows the reliability of soil information from which the map was compiled.

Detailed definitions of the soil units and full descriptions of all the terms used may be found in Volume I.

The text

The first chapter describes the development of the project in North and Central Asia and gives some notes on uses of the map. The second acknowledges the cooperation of the agencies and people who contributed to the maps and text, and the third gives a summary of the material in Volume I on the maps and legend.

The main chapters of this volume deal with environmental conditions and use of soils and land.

Environmental conditions

Chapter 4 deals with the environmental factors that are important in the development of soils: climate, vegetation, geotectonics, geomorphology and lithology.

Climate is discussed on the basis of nine broad climatic types related to general physico-geographical regions of the continent. Since the criteria used in delimiting units are those that are important to crop growth, the climatic map is supplementary to the soil map in the transfer of crop information from one part of the continent to another. Here only the higher categories are discussed. The main climatic regions are outlined on a small-scale map (Figure 1).

Vegetation is discussed on the basis of 11 broad vegetation regions and 39 regions distinguished on the basis of the habitat (either climatic or edaphic), and of the physiognomy and structure of the vegetation. These are outlined on a small-scale map (Figure 2). The text gives some brief notes on each broad region and on the location and nature of the regions.

Geotectonics and *geomorphology* are examined in terms of main groups of regions which are shown on small-scale maps (Figures 3 and 4).

Lithology is considered under 20 broad lithological types outlined in Figure 5. The text outlines the geological origins and nature of the main surface deposits.

Soils and land use

Chapters 5 and 6 describe the soils of the continent. They contain an extensive table of soil associations, an account of the distribution of the main soils, and a discussion of land use and soil suitabilities for agriculture.

The table of soil associations lists all the map units in alphabetical order of symbols and shows associated soils, inclusions, phases, areas of units in 1 000 ha, climate symbols, and countries of occurrence.

The distribution of major soils is discussed on the basis of 113 soil regions grouped into 11 soil-bioclimatic provinces of four broad soil-bioclimatic belts. They are outlined on a small-scale map (Figure 6) and listed in Table 4 in alphabetical order of symbols. The main soils of each region are discussed in relation to environmental factors and their important characteristics are noted.

Present land use and suitabilities for agriculture are discussed at first in general with an account of traditional and modern farming systems. Then the main soil units are considered separately. Their present use is described, and the suitability of the land for both traditional and modern farming is outlined.

The pattern of land use shows that only a small part (no more than 10 percent) of the land is under cultivation. Most of this is on the margins of the continent, and huge areas are not used for agriculture. Agricultural production can be substantially increased by utilizing soil resources at present unused and by making better use of soils now under cultivation.

Conclusions

An outstanding feature of the soils of North and Central Asia is their varied natural fertility, ranging from the richest Chernozems and deltaic Fluvisols and Gleysols to the poorest desert soils. This is not surprising in such a huge continent with a great variety of environmental conditions, but the most fertile soils occur on its eastern, western and southern margins, leaving its central and northern parts little utilized. Large-scale agriculture cannot be developed in the greater part of the continent because of severe environmental and soil limitations.

One of the major constraints affecting agricultural use of soils is deficiency of water. A large part of central Asia has semiarid or arid climates, making rainfed agriculture hazardous or impossible. The soils are mainly Yermosols, Xerosols, Lithosols, and salt-affected soils such as Solonchaks and Solonetz; shifting sands occupy large areas in the deserts.

There are also extensive areas with poor drainage, especially in the northern part of the continent. Here soils are mostly Gleysols or soils of Gleyic units.

Soils with permafrost (Gelic units) occupy large areas in the north. The severe climatic conditions of these soils are a major limitation to agriculture.

Steeplands cover about half of the continent. Apart from Lithosols, which are dominant, a great variety of soils occur in the mountain systems of North and Central Asia, in accordance with the environmental conditions. Most of them are lithic and are usually stony. They may be Eutric or Dystric, acid or alkaline, well-drained or Gleyic, or even Gelic, depending on the altitude, geology and geographic position of the mountain system. Most of these areas can be utilized only for mountain pasture or forest.

Soil regions not having such drastic limitations to agricultural development are limited. Important soils of these regions are Greyzems, Chernozems, Kastanozems, some Xerosols, Gleysols and Fluvisols.

Although the total area of these productive soils is limited, much of it is still uncultivated or not fully developed. Substantial increases in agricultural production are therefore possible.

The Appendix

Site and profile data, including profile descriptions and analyses, are given in the Appendix for some of the main soil units.

RÉSUMÉ

Le présent volume décrit la partie relative à l'Asie du Nord et du Centre de la Carte mondiale des sols au 1 : 5 000 000. La carte des sols de l'Asie du Nord et du Centre a été dressée par la FAO et l'Unesco dans le cadre d'un projet conjoint lancé en 1961, en étroite coopération avec les institutions gouvernementales intéressées.

Les cartes

Les feuilles cartographiques qui constituent la carte des sols de l'Asie septentrionale et centrale ont été établies d'après le fond topographique au 1 : 5 000 000 de l'American Geographical Society. Les unités cartographiques sont des associations d'unités pédologiques divisées en classes de texture et de pente du sol. Elles sont indiquées sur la carte par des symboles. Les sols dominants sont représentés par des couleurs et les phases par des surcharges.

Un petit carton indique le degré de fiabilité des renseignements pédologiques d'après lesquels la carte a été établie.

On trouvera dans le volume I des définitions détaillées des unités pédologiques et une description complète de tous les termes utilisés.

Le texte

Le premier chapitre fait l'historique du projet en Asie septentrionale et centrale et donne quelques informations sur les utilisations de la carte. Le deuxième chapitre rend hommage aux institutions et aux personnes qui ont contribué à l'établissement des cartes et du texte; le troisième donne un résumé du contenu du volume I concernant les cartes et la légende.

Les principaux chapitres du présent volume traitent du milieu et de l'utilisation des sols et des terres.

Le milieu

Le chapitre 4 expose les facteurs du milieu qui ont une importance pour l'évolution des sols: climat, végétation, géotectonique, physiographie et lithologie.

Le *climat* est traité en neuf grands types climatiques en rapport avec les régions physico-géographiques du continent. Etant donné que les critères utilisés pour délimiter les unités sont les plus importants pour la croissance végétale, on peut dire que la carte climatique complète la carte pédologique pour le transfert des données concernant les cultures d'une partie du continent à une autre. Seules les catégories supérieures ont été étudiées. Les principales régions climatiques sont représentées sur une carte à petite échelle (figure 1).

La *végétation* est traitée en 11 grandes régions végétales et 39 régions établies en fonction de l'habitat (soit climatique, soit édaphique) ainsi que de la physionomie et de la structure de la végétation. Ces régions sont représentées sur une carte à petite échelle (figure 2). Le texte fournit quelques brèves indications sur chaque grande région ainsi que sur l'emplacement et la nature des régions.

La *géotectonique* et la *physiographie* sont étudiées dans le cadre de principaux groupes de régions, qui sont représentés sur des cartes à petite échelle (figures 3 et 4).

La *lithologie* est traitée dans le cadre de 20 grands types lithologiques, localisés sur la figure 5. Le texte décrit les origines géologiques et la nature des principaux dépôts de surface.

Les sols et leurs utilisations

Les chapitres 5 et 6 décrivent les sols du continent. Ils contiennent un tableau détaillé des associations de sols, une étude de la répartition des principaux sols et un examen de l'utilisation des terres et de leur vocation agricole.

Le tableau des associations de sols énumère toutes les unités cartographiques dans l'ordre alphabétique des symboles et comporte les rubriques suivantes: sols associés, inclusions, phases, superficie en millier d'hectares, climat et localisation par pays.

La répartition des principaux sols est faite sur la base de 113 régions pédologiques, groupées en 11 provinces pédo-bioclimatiques et quatre grandes ceintures pédo-bioclimatiques. Elles sont délimitées sur une carte à petite échelle (figure 6) et énumérées au tableau 4 dans l'ordre alphabétique des symboles. Les principaux sols de chaque région sont étudiés par rapport aux facteurs du milieu et leurs caractéristiques importantes sont signalées.

L'utilisation actuelle des sols et leur vocation agricole font d'abord l'objet d'une étude générale, accompagnée d'une description des différents systèmes agricoles, traditionnels et modernes. Les principales unités pédologiques sont ensuite étudiées séparément. On décrit leur utilisation actuelle ainsi que l'aptitude des terres à l'agriculture, tant traditionnelle que moderne.

La structure de l'utilisation des terres montre qu'une faible part seulement (pas plus de 10 pour cent) de celles-ci est cultivée, essentiellement sur les franges du continent, tandis que des superficies immenses ne sont pas exploitées. Il est donc possible d'augmenter considérablement la production agricole, d'une part en mettant en valeur des ressources en sols encore inutilisées, et d'autre part en tirant un meilleur parti des sols actuellement en culture.

CONCLUSIONS

L'un des traits marquants des sols de l'Asie septentrionale et centrale est le caractère varié de leur fertilité naturelle qui va des plus riches chernozems et des fluvisols et gleysols deltaïques aux sols désertiques les plus pauvres. Cela ne saurait surprendre dans un continent aussi vaste où les conditions du milieu varient énormément. Mais les sols les plus fertiles se trouvent sur les bordures est, ouest et sud du continent, ce qui fait que le centre et le nord sont peu exploités. La plus grande partie du continent ne se prête pas à une mise en valeur agricole à grande échelle en raison de graves contraintes du milieu et des sols.

Parmi ces contraintes, l'une des plus importantes pour l'utilisation agricole des sols est le manque d'eau. Les climats d'une grande partie de l'Asie centrale sont semiarides ou arides, ce qui rend l'agriculture pluviale hasardeuse ou impossible. Les sols sont essentiellement des yermosols, des xérosols, des lithosols et des sols affectés par le sel comme les solonchaks et les solonetz; des sables mobiles occupent de grandes superficies dans les déserts.

Il existe aussi de vastes superficies mal drainées, en particulier dans le nord du continent où les sols sont principalement des gleysols ou des sols des unités gleyiques.

Les sols à permafrost (unités géliques) occupent d'immenses étendues dans le nord. Le climat rigoureux de ces sols est la principale entrave à l'agriculture.

Les terrains accidentés occupent environ la moitié du continent. En dehors des lithosols, qui sont les sols dominants, on trouve dans les systèmes montagneux du nord et du centre de l'Asie une gamme très variée de sols, en rapport avec les conditions du milieu. La plupart sont lithiques et généralement pierreux. Ils peuvent être eutriques ou dystriques, acides ou alcalins, bien drainés ou gléyiques, voire géliques selon l'altitude, la géologie et la position géographique du système montagneux. La plupart de ces régions ne peuvent être exploitées qu'en pâturages de montagne ou pour les forêts.

Les régions pédologiques ne présentant pas des limitations aussi rigoureuses à la mise en valeur agricole sont peu nombreuses. Les sols importants de ces régions sont des greyzems, des chernozems, des kastanozems, parfois des xérosols, des gleysols et des fluvisols. Bien que la superficie totale de ces sols productifs soit limitée, une bonne partie est encore non cultivée ou non entièrement mise en valeur. Il est donc possible d'augmenter considérablement la production agricole.

Annexe

On trouvera dans l'Annexe des renseignements concernant les sites et les profils y compris des descriptions et des analyses de profils, pour certaines des principales unités pédologiques.

РЕЗЮМЕ

Резюме

В данном томе изложено описание раздела Северной и Центральной Азии почвенной карты мира масштаба 1:5 000 000. Составление почвенной карты Северной и Центральной Азии было завершено ФАО и ЮНЕСКО по совместному проекту, осуществление которого было начато в 1961 году в тесном сотрудничестве с заинтересованными правительственными учреждениями.

Карты

Листы карты, образующие почвенную карту Северной и Центральной Азии, вычерчены на топографической основе 1:5 000 000 Американского географического общества. Картографические единицы - это почвенные ассоциации, подразделенные на классы в зависимости от структуры и рельефа. Они показаны на карте индексами. Преобладающие почвы выделены краской, фазовые различия - штриховкой.

Малая карта-врезка показывает достоверность данных о почве, на основе которых составлялась карта.

В первом томе содержатся подробные определения почвенных единиц и полные описания всех примененных терминов.

Текст

В первой главе говорится о разработке проекта в Северной и Центральной Азии и содержатся некоторые замечания о пользовании картами. Во второй главе выражается признательность за сотрудничество учреждениям и лицам, которые приняли участие в составлении карт и подготовке текста, и в третьей главе дано резюме материалов по картам и легенде.

Основные главы этого тома посвящены условиям окружающей среды и использованию почв и земли.

Условия окружающей среды

В главе 4 излагаются факторы окружающей среды, имеющие большое значение для развития почв: климат, растительность, геотектоника, геоморфология и литология.

Климат рассматривается на основе 9 широких климатических типов, связанных с общими физико-географическими регионами континента. Поскольку для определения единиц использованы критерии, имеющие большое значение для роста зерновых, климатическая карта дополняет почвенную карту в плане передачи сведений о зерновых из одной части континента в другую. В данном случае даются только более высокие категории. На мелкомасштабной карте /схема 1/ указаны основные климатические зоны.

Растительность рассматривается на основе 11 обширных зон растительности и 39 зон, выделяемых в зависимости от естественной среды /климатической или почвенной/, а также физиогномики и структуры растительности. Они указаны на мелкомасштабной карте /схема 2/. В главе приводятся некоторые краткие замечания по каждой обширной зоне, а также относительно расположения и характера зон.

Геотектоника и геоморфология рассматриваются по основным группам регионов, которые показаны на мелкомасштабных картах /схемы 3 и 4/.

Литология рассматривается по 20 обширным литологическим разновидностям, указанным на схеме 5. В тексте говорится о геологической природе и характере основных поверхностных отложений.

Использование почв и земли

В главах 5 и 6 дается описание почв континента. Они содержат обширную таблицу почвенных ассоциаций, сведения о распределении основных почв, землепользовании и пригодности почв для сельского хозяйства.

В таблице почвенных ассоциаций в алфавитном порядке индексов приводится перечень всех картографических единиц и указаны сопутствующие почвы, спорадические фазы, районы единиц в 1 000 га, климатические индексы и страны, в которых они установлены.

Распределение основных почв указывается на основе 113 почвенных зон, сгруппированных в 11 почвенно-биоклиматических областей 4-х широких почвенных биоклиматических поясов. Они указаны на мелкомасштабной карте /схема 6/ и приведены в таблице 4 в алфавитном порядке индексов. Основные почвы каждой зоны рассматриваются в связи с факторами окружающей среды и отмечаются их важные особенности.

Нынешнее использование земли и ее пригодность для сельского хозяйства рассматриваются вначале в целом с учетом традиционных и современных систем земледелия. Затем отдельно рассматриваются основные почвенные единицы. Указывается их нынешнее использование и пригодность земли для традиционного и современного земледелия.

Структура землепользования свидетельствует о том, что только небольшая часть / не более 10 проц./ земли обрабатывается. Большая ее часть находится на окраинах континента и огромные области не используются для сельского хозяйства. Сельскохозяйственное производство можно значительно увеличить путем использования почвенных ресурсов, в настоящее время не используемых, и путем лучшего использования тех почв, которые обрабатываются в настоящее время.

Выводы

Основной чертой почв Северной и Центральной Азии является их разнообразное природное плодородие: от богатейших черноземов и дельтовых флювисолей и глеевых почв до беднейших бесплодных почв. Это и не удивительно для такого огромного континента с большим разнообразием условий окружающей среды, но самые плодородные почвы находятся на его восточных, западных и южных окраинах, а его центральные и северные части мало используются. На большей части континента невозможно развивать сельское хозяйство в широком плане в силу суровых природных условий и почвенных ограничений.

Одним из основных препятствий использованию почв в сельскохозяйственных целях является нехватка воды. На большей части Центральной Азии преобладает полузасушливый или засушливый климат, что делает неорошаемое земледелие неустойчивым или невозможным. Почвы - главным образом ермосоли, ксеросоли, литосоли и такие солончаковые почвы, как солончаки и солонцы; движущиеся пески занимают огромные районы в пустынях.

Имеются также обширные районы с плохим дренажем особенно в северной части континента. Здесь почвы являются главным образом глеевыми или оглеенными.

Почвы с вечной мерзлотой /криогенные единицы/ занимают большие районы на севере. Суровые климатические условия являются основным препятствием для развития сельского хозяйства на этих почвах.

Горные районы занимают около половины континента. Кроме

преобладающих литосолей в соответствии с условиями окружающей среды большое разнообразие почв наблюдается в горных системах Северной и Центральной Азии. Большинство из них каменистые. Они могут быть богатыми или бедными, кислыми или щелочными, хорошо осушенными или глеевыми или даже криогенными в зависимости от высоты, геологии и географического положения горной системы. Большинство из этих районов могут быть использованы только для горных пастбищ или лесов.

Почвенные зоны, в которых нет таких серьезных препятствий для развития сельского хозяйства, немногочисленны. Важные почвы этих районов - грейземы, черноземы, каштаноземы, некоторые ксеросоли, глейсоли и флювисоли.

Хотя общая площадь этих продуктивных почв ограничена, большая их часть все еще не обрабатывается или не используется полностью. Значительное увеличение сельскохозяйственного производства, следовательно, возможно.

Приложение

Данные о расположении и профилях, включая описания и анализы профилей по некоторым из основных почвенным единицам приводятся в приложении.

RESUMEN

En el presente volumen se describe la sección correspondiente al Norte y el Centro de Asia, del Mapa Mundial de Suelos, a escala 1 : 5 000 000. El trazado del Mapa de Suelos del Norte y el Centro de Asia fue realizado por la FAO y la Unesco en un proyecto conjunto iniciado en 1961, en estrecha cooperación con las instituciones gubernamentales interesadas.

Los mapas

Las láminas que componen el Mapa de Suelos del Norte y el Centro de Asia están trazadas sobre mapas topográficos de base de la serie 1 : 5 000 000 de la American Geographical Society. Las unidades topográficas son asociaciones de unidades edáficas divididas en clases según la textura y la inclinación. En los mapas están señaladas con símbolos. Los suelos dominantes se indican mediante colores y las fases mediante sobreimpresiones.

Un pequeño mapa inserto indica la fiabilidad de la información sobre el suelo que ha servido de base para trazar el mapa.

En el Volumen I figuran definiciones detalladas de las unidades edáficas y descripciones completas de todos los términos empleados.

El texto

El primer capítulo describe el desarrollo del proyecto del Norte y el Centro de Asia Central y da algunas indicaciones sobre el uso del mapa. En el segundo se hace constar la cooperación de los organismos y de las personas que han contribuido a la preparación de los mapas y del texto, y el tercer capítulo ofrece un resumen del material contenido en el Volumen I sobre los mapas y las leyendas respectivas.

Los capítulos principales de este volumen tratan de las condiciones ambientales y del uso de suelos y tierras.

Condiciones del medio

El Capítulo 4 se ocupa de los factores ambientales que influyen en la evolución de los suelos: clima, vegetación, geotectónica, geomorfología y litología.

El *clima* se examina sobre la base de nueve amplios tipos climáticos correspondientes a las regiones fisicogeográficas generales del continente. Como los criterios empleados para delimitar unidades son los criterios importantes para el crecimiento de las plantas, el mapa climático complementa el mapa de suelos en lo referente a la transmisión de información sobre cultivos de una parte del continente a la otra. Aquí se examinan únicamente las categorías superiores. Las regiones climáticas fundamentales se exponen en un mapa a escala reducida (Figura 1).

La *vegetación* se estudia sobre la base de 11 amplias regiones de vegetación y 39 regiones delimitadas con arreglo al hábitat (climático o edáfico), y a la fisonomía y estructura de la vegetación. Estas regiones se exponen en un mapa a escala reducida (Figura 2). El texto contiene algunas notas breves sobre cada región general y la ubicación y naturaleza de las regiones.

La *geotectónica* y la *geomorfología* se examinan con arreglo a los principales grupos de regiones, que se ilustran en mapas a escala reducida (Figuras 3 y 4).

La *litología* se considera en 20 tipos litológicos generales, expuestos en la Figura 5. El texto describe los orígenes geológicos y naturaleza de los yacimientos principales de la superficie.

Los suelos y el uso de la tierra

Los Capítulos 5 y 6 describen los suelos del continente. Contienen un extenso cuadro de asociaciones de suelos, una relación de la distribución de los suelos principales, y un examen del empleo de la tierra y el potencial de los suelos para la agricultura.

El cuadro de asociaciones de suelos enumera todas las unidades topográficas en orden alfabético de los símbolos y muestra: los suelos asociados, las inclusiones, las fases, las superficies de unidades en 1 000 hectáreas, los símbolos climáticos, y los países de ubicación.

La distribución de los suelos principales se examina en función de 113 regiones edáficas, agrupadas en 11 provincias suelo-bioclimáticas de cuatro zonas generales suelo-bioclimáticas, que se exponen en un mapa a escala reducida (Figura 6) y se enumeran en el Cuadro 4, en orden alfabético de símbolos. Los suelos principales de cada región se examinan en relación con los factores ambientales, y se indican sus características importantes.

El empleo actual de la tierra y las posibilidades para la agricultura se tratan en primer lugar en términos generales, con una relación de los sistemas de cultivo tradicionales y modernos. A continuación, se analizan por separado las principales unidades edáficas. Se describe su uso actual, y las posibilidades de la tierra para los cultivos tradicionales y modernos.

El esquema del empleo de la tierra muestra que sólo una pequeña parte (no más del 10 por ciento) de la tierra se cultiva. En su mayoría está situada en los márgenes del continente, mientras que inmensas superficies no se dedican a la agricultura. La producción agrícola puede incrementarse sustancialmente empleando los recursos del suelo que ahora no se aprovechan, y mejorando el empleo de los suelos que actualmente se cultivan.

Conclusiones

Una característica destacada de los suelos del Norte y el Centro de Asia es su variada fertilidad natural, encontrándose desde los feracísimos suelos chernozems y fluvisoles y gleysoles deltaicos, hasta los más pobres y desérticos. Ello no es sorprendente en un continente inmenso con una gran variedad de condiciones ambientales, pero los suelos más fértiles se encuentran en sus márgenes oriental, occidental y meridional, quedando las zonas centrales y septentrionales poco utilizadas. La agricultura a gran escala no puede desarrollarse en la mayor parte del continente, a causa de graves limitaciones ambientales y del suelo.

Una de las limitaciones mayores que afectan al empleo de la agricultura y del suelo es la escasez de agua. Gran parte de Asia Central tiene climas semiáridos o áridos, lo que hace que la agricultura de secano sea arriesgada o imposible. Los suelos son principalmente yermosoles, xerosoles, litosoles, y suelos de carácter salino como el solonchak, y el solonetz; arenas movedizas ocupan grandes zonas del desierto.

También existen extensas áreas de escaso drenaje, especialmente en la parte septentrional del continente. En este sector, los suelos son fundamentalmente gleysoles o suelos de unidades gleicas.

Los suelos de horizonte permanentemente helado (unidades gélicas) ocupan amplias zonas en el norte. Las extremadas condiciones climáticas de estos suelos representan una gran limitación para la agricultura.

La mitad aproximadamente del continente está constituida por tierras montañosas. Aparte de los litosoles, que son dominantes, una gran variedad de suelos se encuentran en los sistemas montañosos del Norte y el Centro de Asia, en concomitancia con las condiciones ambientales. La mayor parte de estos suelos son líticos y normalmente pedregosos. Pueden ser éutricos o dístricos, ácidos o alcalinos, bien drenados o gleicos, o incluso gélicos, según la altitud, geología y posición geográfica del sistema montañoso. La mayor parte de estas zonas pueden utilizarse únicamente para pastos o bosques.

Las regiones con suelos que no adolecen de tan drásticas limitaciones para el desarrollo agrícola son pocas. Suelos importantes de estas regiones son los greyzems, chernozems, kastanozems, algunos xerosoles, gleysoles y fluvisoles.

Aunque el área total de suelos productivos es limitada, la mayor parte de ella se encuentra aún sin cultivar o no está del todo aprovechada. Por consiguiente, es posible conseguir un incremento sustancial de la producción agrícola.

Apéndice

En el Apéndice figuran datos sobre situación y perfiles, incluyendo descripciones y análisis de perfiles para algunas de las principales unidades edáficas.

1. INTRODUCTION

History of the project [1]

Recognizing the need for an integrated knowledge of the soils of the world, the Seventh Congress of the International Society of Soil Science, held at Madison, Wisconsin, U.S.A., in 1960, recommended that ways and means be found for the publication of soil maps of the great regions of the world. As a follow-up to this recommendation, FAO and Unesco agreed in 1961 to prepare jointly a Soil Map of the World based on the compilation of available soil survey material and on additional field correlation. The secretariat of the joint project was located at FAO Headquarters in Rome. It was responsible for collecting and compiling the technical information, undertook correlation studies, and drafted the maps and text.

In June 1961 an advisory panel composed of prominent soil scientists representing various parts of the world was convened by FAO and Unesco to study the methodological, scientific and various other problems related to the preparation of a Soil Map of the World. In the following years several advisory panel meetings were held and general points were discussed at the eighth and ninth congresses of the International Society of Soil Science.

In 1962 the First Soil Correlation Seminar for South and Central Asia was held at Tashkent, U.S.S.R., and was followed by a field excursion in middle Asia. It was attended by a large number of representatives of different countries. Correlation of the main soils of arid and semiarid Asian regions was discussed in the field. In 1964 a meeting on classification and correlation of soils from volcanic ash was held in Tokyo, Japan. Numerous Far Eastern soils were discussed at the meeting and during the excursions and field correlation trips that followed.

A first draft of a soil map of Asia presented by Soviet soil scientists at the Seventh Congress of the International Society of Soil Science in Madison was published in Moscow in 1964 and presented at the Society's Eighth Congress in Bucharest. This map reflected a considerable amount of knowledge obtained through soil survey programmes in different Asian countries. A third draft of this map was published in the U.S.S.R. in 1971.

Several meetings were held by the advisory panel during that time, providing new ideas and bases for further correlations.

A soil map of China prepared by the Soil Institute of the Chinese Academy of Sciences was made available to the project in 1974.

These maps were taken as a basic source of information for the preparation of the present draft of the Soil Map of North and Central Asia. Adaptation and correlation of the legends of the various maps used with the FAO legend for the Soil Map of the World were carried out by FAO in close cooperation with the Soil Institute of the Chinese Academy of Sciences, the Society of Forest Environment of Japan, the Institute of Geography of the Mongolian Academy of Sciences, the Food and Fertilizer Technology Centre of the Asian and Pacific Council (ASPAC), the Institute of Plant Environment of the Republic of Korea, the Ministry of Agriculture of the Democratic People's Republic of Korea, and the U.S.S.R. All-Union Society of Soil Scientists.

The main sources of information for the countries concerned are outlined in Chapter 3.

Objectives

Transfer of knowledge and experience from one area of the earth to another can only be successful when allowance is made for similarities and differences in the geographical, soil and climatic conditions of the regions or countries involved. Furthermore, the economic feasibility of different management techniques under prevailing socio-economic conditions needs to be assessed before they can be recommended for adoption. In order to do so, reliable information on the nature and distribution of the major soils of the world is of fundamental importance. However, the preparation of regional and continental soil maps

[1] This section refers mainly to the preparation of the Soil Map of North and Central Asia. The history of the project as a whole is dealt with more completely in Volume I.

requires a uniform legend and nomenclature and the correlation of existing soil classification systems. One of the principal objectives of the FAO/Unesco Soil Map of the World project was to foster a spirit of cooperation among soil scientists all over the world which would lead to agreement on an international soil correlation system.

In North and Central Asia agricultural research is centred mainly on increased output from croplands and pastures. However, vast areas have scarcely been touched by man and are only now being studied to evaluate their future role in providing food for the rapidly increasing population. This study attempts to present a synthesis of the knowledge available on the soils of North and Central Asia. It is hoped that it will promote better understanding among soil scientists, planners and farmers, provide useful coordination of national and international soil studies, and stimulate applied research.

Value and limitations of the map

The Soil Map of North and Central Asia is meant to be a source of factual data, providing a basis and framework for further regional and national soil surveys at a more detailed scale. It may assist in selecting methods for reclamation, crop production, fertilizer application and general use of soils. Until now all attempts to make overall plans or forecasts for agriculture have been hampered by lack of uniformity in the terminology, nomenclature and classification of soils, and by lack of a comprehensive picture of the world's soil resources.

Through a systematic interpretation of the Soil Map of the World it will be possible to make an appraisal of the distribution and the production potential of the major soils on a continental basis and to delineate broad priority areas which deserve further study. This inventory of soil resources will bring to light the limitations and potentialities of the different regions for increased food production.

In addition, a continental soil map such as the Soil Map of North and Central Asia can be a valuable teaching aid for the training of geographers, soil scientists, agronomists and all those who are involved in the study of the environment.

Although the publication of the map and text marks a significant step forward, it is necessary to point out its inherent limitations. The accuracy and detail of the information which can be shown are obviously limited by the small scale of the map and by the fact that soil data for some areas are scarce because of inadequate field correlation or lack of direct observations. On the other hand, differences in field and laboratory study methods present difficulties in the preparation of continental maps. These limitations also apply to the interpretative data, since they can only be as accurate as the information on which they are based.

Despite these shortcomings, the Soil Map of North and Central Asia is the most recent and detailed inventory of soil resources based on international cooperation. Its limitations emphasize the need for intensified soil correlation and for obtaining better knowledge of the nature and distribution of soils in parts of the continent where information is lacking or inadequate.

Use of the map and explanatory text

Against the background of the topographic base, the soil map shows the broad pattern of dominant soils, marked by different colours. Clusters of closely related colours have been used for soils which have similar characteristics so that major soil regions can be recognized.

More detailed information about each map unit can be derived from the soil association symbols. The composition of the soil associations is given in Chapter 5, in which they are listed in alphabetical order of symbols together with their areas, locations, and climates. A table showing the composition of the soil associations also appears on the back of the maps.

The meanings of the textural and slope classes indicated by the map unit symbols and of the overprints indicating phases are given on the soil map and are further described in Chapter 3. The definitions of the soil units involved are in Volume I. The profile descriptions and analytical data in the Appendix illustrate and further clarify the soil definitions.

The geographical distribution of the soils is indicated in Chapter 5. For this purpose the continent has been subdivided into several major physiographic units which have been subdivided into 113 soil regions.

For information on the occurrence, land use, limitations, suitabilities and potentialities of the soil units, Chapter 6 should be consulted. Here the specific management problems of the soil units are discussed.

Those who are interested not only in the nature, distribution and suitabilities of the soils (the "agricultural angle"), but also in the natural environment, will find additional reading in Chapter 4. This chapter deals with climate, with vegetation (which in great parts of North and Central Asia can still be observed in its natural state), with geomorphology (supplementing information in the chapter on the distribution of soils) and with lithology.

2. ACKNOWLEDGEMENTS

The preparation of the Soil Map of North and Central Asia could only be accomplished with the cooperation of government institutions and many soil scientists who provided basic material and took an active part in the meetings, study tours and discussions which led to the various drafts of the map and text.

It is not possible to name all those on whose work the Soil Map of North and Central Asia is based, although some of the contributors are named in the following chapter in the sources of information section. Their contributions are acknowledged through the Soil Institute of the Chinese Academy of Sciences, the Society of Forest Environment of Japan, the Institute of Geography of the Mongolian Academy of Sciences, the Food and Fertilizer Technology Centre of the Asian and Pacific Council (ASPAC), the Institute of Plant Environment of the Republic of Korea, the Ministry of Agriculture of the Democratic People's Republic of Korea, and the U.S.S.R. All-Union Society of Soil Scientists.

The transformation of the Soil Map of Asia at 1 : 6 000 000 scale, edited by V.A. Kovda and E.V. Lobova of the Dokuchaiev Institute of Soil Science, U.S.S.R., into the present 1 : 5 000 000 Soil Map of North and Central Asia, the correlation with the FAO legend and the preparation of the explanatory text were done by B.G. Rozanov.

Correlation of a soil map of China at 1 : 10 000 000 scale, prepared by the Soil Institute of the Chinese Academy of Sciences, with the FAO legend and editorial work on the explanatory text of the Soil Map of North and Central Asia were carried out by A. Pécrot (FAO).

The responsibility for intercontinental correlation, preparation of the international legend and definition of soil units was entrusted to R. Dudal (FAO).

All original drafts of the map were done by D. Mazzei, M. Zanetti and P. Barbasso (FAO).

Grateful acknowledgement is made of the permission given by the American Geographical Society of New York to use its 1 : 5 000 000 World Map as a basis for the preparation of the Soil Map of the World.

3. THE MAP

Topographic base

The Soil Map of North and Central Asia was prepared on the basis of the 1 : 5 000 000 topographic map series of the American Geographical Society of New York, assuming an average radius of the earth of 6 378 388 metres. For North and Central Asia, this map is in three sheets divided between the longitudes 89° to 95°E and the latitudes 34° to 54°N, the two northern sheets adjoining and the southern sheet partly overlapping the others. The Miller oblated stereographic projection was used to prevent distortion of the original areas.

It should be noted that the topographic base is dated 1964. Updating would be required to reflect current conditions, since boundaries indicated on the base as undemarcated have since been defined; others are disputed; and others do not appear on the base at all. Similarly, certain geographical names have been modified, or names earlier modified have gained wider international recognition. Since the Soil Map of the World is essentially a thematic map, the base having been selected only as a matter of convenience, users are referred for questions of boundaries and names to the topographic maps issued by governments. Attention is also invited to the geographical disclaimer which appears on page *iv* of this volume and on each sheet of the Soil Map of the World.

Areas of land surfaces measured directly on the map with a planimeter are subject to variations due to the projection of less than 8 percent. Distances between land points measured directly on the map are subject to errors of less than 4 percent. The accuracy can be greatly improved by use of the key map on the American Geographical Society map, which gives lines of equal scale departure and conversion tables based on mean scale departure ratio.

Map units

The map unit consists of a soil unit or of an association of soil units, the latter predominating. The textural class is indicated for the dominant soil unit while a slope class reflects the topography in which the soil association occurs. Furthermore, the associations may be phased according to the presence of indurated layers or hard rock at shallow depth, stoniness, salinity, alkalinity, or ground water influence. The soil units, classes and phases are defined in Volume I.

Each soil association is composed of dominant and subdominant soil units, the latter estimated to cover at least 20 percent of the delimited area. Important soil units which cover less than 20 percent of the area are added as inclusions.

The symbols of the map units show the soil unit, textural class and slope class as follows:

1. Soil units

The symbols used for the representation of the soil units are those shown in the list of soil units on the back of the map. They are also listed in Table 1.

2. Textural classes

The textural classes, coarse, medium and fine, are shown by the symbols 1, 2 and 3 respectively.

3. Slope classes

The slope classes, level to gently undulating, rolling to hilly and strongly dissected to mountainous, are indicated by the letters a, b and c respectively.

Cartographic representation

Symbols

The soil associations have been noted on the map by the symbol representing the dominant soil unit, followed by a figure which refers to the descriptive legend on the back of the map in which the full composition of the association is outlined.

Example:	Af50	Ferric Acrisols and Lithosols
	Bc21	Chromic Cambisols and Calcic Cambisols

Associations in which Lithosols are dominant are marked by the Lithosol symbol I combined with one or two associated soil units.

Example: I-Dd Lithosols and Dystric Podzoluvisols

I-K-U Lithosols, Kastanozems and Rankers

If information on the texture of the surface layers (upper 30 cm) of the dominant soil is available, the textural class figure follows the association figure, separated from it by a dash.

Example: Ao87-3 Orthic Acrisols, fine-textured, and Ferric Acrisols

Xl21-1 Luvic Xerosols, coarse-textured, and Orthic Solonetz

Where two groups of textures occur that cannot be delimited on the map, two figures may be used.

Example: Bx11-2/3 Gelic Cambisols, medium- and fine-textured, and Dystric Histosols

Where information on relief is available, the slope classes are indicated by a small letter (a, b or c) immediately following the textural notation.

Example: Je2-2a Eutric Fluvisols, medium-textured, level to gently undulating

In complex areas where two types of topography occur that cannot be delimited on the map, two letters may be used.

Example: Jc55-2ab Calcaric Fluvisols, medium-textured, and Calcic Cambisols, level to rolling

If information on texture is not available, the small letter indicating the slope class will immediately follow the association symbol.

Example: I-U-c Lithosols and Rankers, steep

Map colours

The soil associations have been coloured according to the dominant soil unit. Each of the soil units used for the Soil Map of the World has been assigned a specific colour. The distinction between map units is shown by a symbol on the map.

The colour selection is made by clusters so that "soil regions" of genetically related soils will show up clearly.

If insufficient information is available to specify the dominant soil unit, the group of units as a whole is marked by the colour of the first unit mentioned in the list of soil units in Volume I (e.g. the colour

TABLE 1. – SOIL UNITS FOR NORTH AND CENTRAL ASIA [1]

J	FLUVISOLS
Je	Eutric Fluvisols
Jc	Calcaric Fluvisols
Jd	Dystric Fluvisols
Jt	Thionic Fluvisols
G	GLEYSOLS
Ge	Eutric Gleysols
Gc	Calcaric Gleysols
Gd	Dystric Gleysols
Gm	Mollic Gleysols
Gh	Humic Gleysols
Gx	Gelic Gleysols
R	REGOSOLS
Re	Eutric Regosols
Rc	Calcaric Regosols
Rd	Dystric Regosols
Rx	Gelic Regosols
I	LITHOSOLS
Q	ARENOSOLS
Qc	Cambic Arenosols
U	RANKERS
T	ANDOSOLS
To	Ochric Andosols
Tm	Mollic Andosols
Th	Humic Andosols
Tv	Vitric Andosols
V	VERTISOLS
Vp	Pellic Vertisols
Z	SOLONCHAKS
Zo	Orthic Solonchaks
Zm	Mollic Solonchaks
Zt	Takyric Solonchaks
Zg	Gleyic Solonchaks
S	SOLONETZ
So	Orthic Solonetz
Sm	Mollic Solonetz
Sg	Gleyic Solonetz
Y	YERMOSOLS
Yh	Haplic Yermosols
Yk	Calcic Yermosols
Yy	Gypsic Yermosols
Yt	Takyric Yermosols
X	XEROSOLS
Xh	Haplic Xerosols
Xk	Calcic Xerosols
Xy	Gypsic Xerosols
Xl	Luvic Xerosols
K	KASTANOZEMS
Kh	Haplic Kastanozems
Kl	Luvic Kastanozems
C	CHERNOZEMS
Ch	Haplic Chernozems
Ck	Calcic Chernozems
Cl	Luvic Chernozems
Cg	Glossic Chernozems
H	PHAEOZEMS
Hh	Haplic Phaeozems
Hg	Gleyic Phaeozems
M	GREYZEMS
Mo	Orthic Greyzems
Mg	Gleyic Greyzems
B	CAMBISOLS
Be	Eutric Cambisols
Bd	Dystric Cambisols
Bh	Humic Cambisols
Bg	Gleyic Cambisols
Bk	Calcic Cambisols
Bc	Chromic Cambisols
Bf	Ferralic Cambisols
L	LUVISOLS
Lo	Orthic Luvisols
Lc	Chromic Luvisols
Lf	Ferric Luvisols
Lp	Plinthic Luvisols
Lg	Gleyic Luvisols
D	PODZOLUVISOLS
De	Eutric Podzoluvisols
Dd	Dystric Podzoluvisols
Dg	Gleyic Podzoluvisols
P	PODZOLS
Pl	Leptic Podzols
Pg	Gleyic Podzols
Ph	Humic Podzols
W	PLANOSOLS
We	Eutric Planosols
Ws	Solodic Planosols
A	ACRISOLS
Ao	Orthic Acrisols
Af	Ferric Acrisols
Ah	Humic Acrisols
Ap	Plinthic Acrisols
Ag	Gleyic Acrisols
N	NITOSOLS
Nd	Dystric Nitosols
O	HISTOSOLS
Oe	Eutric Histosols
Od	Dystric Histosols
Ox	Gelic Histosols

[1] This table follows the order of presentation of soil units in Volume I.

of Haplic Yermosols to show Yermosols in general, the colour of Orthic Podzols to show Podzols in general and the colour of Ochric Andosols to show Andosols in general).

In associations dominated by Lithosols grey stripes (the Lithosol colour) alternate with stripes of the colour of the associated soil.

Phases

Seven phases are indicated on the soil map by overprints.

The *stony* phase marks areas where the presence of gravel, stones, boulders or rock outcrops makes the use of mechanized agricultural equipment impracticable.

The *lithic* phase shows the presence of shallow soils limited in depth by hard rocks within 50 cm of the surface, and actually between 10 and 50 cm, because if the soil is shallower than 10 cm it is classified as a Lithosol according to the soil definition.

The *petric* and *petrogypsic* phases show the presence of indurated layers (concretionary horizons and hard plinthite respectively) within 100 cm of the surface.

The *saline* phase shows that certain soils of the association (not necessarily the dominant ones) are affected by salt to the extent that they have a conductivity greater than 4 mmhos/cm in some part of the soil within 125 cm of the surface for some part of the year. The phase is intended to mark present or potential salinization.

The *sodic* phase is used for soils which have more than 6 percent saturation with sodium in some part of the soil within 125 cm of the surface. It should be noted that Solonchaks are not shown as saline phases, nor Solonetz as sodic phases, since these soils are saline and sodic respectively by definition. It follows that to pick out all areas with saline soils one should include saline phases plus Solonchaks, and that areas with alkali soils include sodic phases plus Solonetz.

The *phreatic* phase is used for soils with a water table that is relatively high, but not high enough to cause gleying of the soil. It is usually applicable to soils ranging from Greyzems to Yermosols which are mostly dry and well drained, but in some depressions or on ancient river terraces may have several features indicating past or present influence of a high water table. These soils are deeper, contain more humus, are often more clayey and sodic or saline, and are richer in bases and nutrients than the corresponding non-phreatic soils. The phreatic phase shows that certain soils of the association (not necessarily the dominant ones) have a ground water table between 3 and 5 metres from the surface.

Miscellaneous land units

Miscellaneous land units are used to indicate dunes or shifting sands, glaciers and snow caps, salt flats, and rock debris or desert detritus.

Where the extent of the land unit is large enough to be shown separately, the sign may be printed over a blank background. Where the land unit occurs in combination with a soil association, the sign may be printed over the colour of the dominant soil.

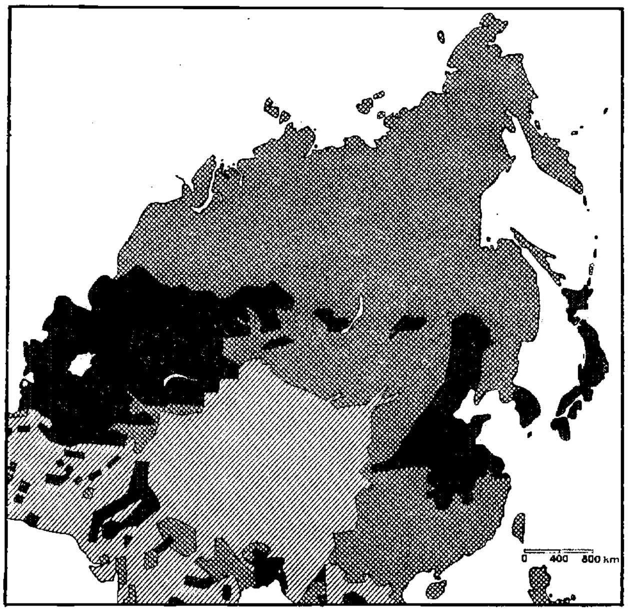
Sources of information

A map showing the sources of information of the Soil Map of North and Central Asia is shown as an inset on the soil map. A separation is made between the areas compiled from systematic soil surveys, soil reconnaissance and general information with local field observations.

Only a small portion of the area is now covered by soil survey maps based on sufficient ground control to be placed in reliability class I. This reflects the general pattern of North and Central Asia, most of which consists of tundra, virgin forests, mountains and deserts with a very sparse population and correspondingly limited land utilization. Furthermore, among the original maps of reliability class I there is inevitably a variation in accuracy depending on a number of factors such as scale, base maps, methodology and purpose of preparation. The use of diverse methods of classification also makes correlation difficult and reduces the reliability of the map. Further uncertainty is introduced by the influence on soil boundaries of differing concepts used in defining the units.

The larger portion of the soil map in reliability class II has been prepared from exploratory soil studies designed to give, in combination with basic information on the natural environment, a fair idea of the composition of the soil pattern. In the preparation of the soil maps of certain areas where there was insufficient coverage by soil surveys, advantage was taken of marked changes in vegetational, geomorphological, lithological and climatic patterns.

Reliability class III refers to areas which are unexplored, or in which occasional soil studies have not supplied sufficient basic data for the compilation of more than a rough sketch of the soil pattern, even at the 1 : 5 000 000 scale. To understand the soil pattern of these regions further studies must be undertaken. However, since most of these areas are sparsely populated and practically inaccessible, they usually have low priority for development. It may take a long time before the necessary data for improving the map will become available.



SOURCES OF INFORMATION

Systematic soil surveys — Soil reconnaissance — General information with local soil observations

The main documents used to compile the Soil Map of North and Central Asia are listed below by country of origin.

Democratic People's Republic of Korea

The main sources available were the 1 : 6 000 000 Soil Map of Asia edited by V.A. Kovda and E.V. Lobova (1971), and various geological and topographical maps. For the preparation of the Soil Map of Asia original material by Kim San Gi, Li Sen Giun, O Zon Man and Zoi O Kir was used.

Japan

The main source was the 1 : 2 000 000 Forest Environment Map of Japan compiled and published by the Society of Forest Environment in 1972.[1] Other maps used were the Soil Map of Japan at 1 : 500 000 scale compiled by M. Oyama, H. Takehara, N. Hashimoto and T. Kurotori; and the 1 : 5 000 000 Geological Map of Asia and the Far East published by Unesco and the Economic Commission for Asia and the Far East (now the Economic and Social Commission for Asia and the Pacific).

[1] At the time the Soil Map of North and Central Asia was being compiled, M. Oyama's updated Soil Map of Japan at 1 : 2 000 000 scale (1975) had not yet appeared.

People's Republic of China

A soil map of China at 1 : 10 000 000 scale and a translation of the legend into English were contributed in 1974 by the Soil Institute of the Chinese Academy of Sciences at Nanking. Another source was the comprehensive description of soil conditions in J. Thorp's study *Geography of the soils of China* (1939).

Republic of Korea

A 1 : 1 000 000 general soil map of the country was prepared by Y.H. Shin of the Institute of Plant Environment in 1972. This map, based on the 1 : 250 000 reconnaissance soil map of the country prepared in 1970 during an Institute of Plant Environment/UNDP/FAO project, was adapted to the FAO/Unesco legend by the author in 1973.

Union of Soviet Socialist Republics

The main source was the 1 : 6 000 000 Soil Map of Asia edited by V.A. Kovda and E.V. Lobova (1971). As neither the texture nor the associated and included soils were shown on this map, the 1 : 4 000 000 Soil Map of the U.S.S.R., the 1 : 2 500 000 Soil Map of Kazakhstan and the 1 : 1 500 000 Soil Map of Uzbekistan were used to obtain additional information on the soil pattern of the U.S.S.R.

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KOVDA, V.A. & LOBOVA, E.V. *Soil Map of Asia to the Proj-*
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4. ENVIRONMENTAL CONDITIONS

This chapter briefly outlines five aspects of the environment that are important in the development of soils. These are climate, vegetation, geotectonics, geomorphology and lithology.

These outlines, each of which is complemented by a small-scale map at the back of this volume, indicate the natural conditions of the major regions in which important variants occur.

Asia occupies nearly one third of the earth's land surface, from the equator to 77° 44'N, and includes all climatic belts from equatorial to arctic. This, combined with the influence of the relief, accounts for the great diversity of geographical zones and regions. In addition, the surrounding seas and oceans with their characteristic air masses and high-pressure zones affect the climates and other natural conditions of different parts of the continent.

In the north, Asia is bordered by the Arctic Ocean, which is covered with ice most of the year. Here, as in the vast area of Siberia, large masses of extremely cold arctic and polar air form in the winter, affecting all the northern and eastern parts of the continent up to the subtropical zone.

The unequal conditions of heating and cooling of the world's largest continent and largest ocean induces in eastern Asia strong seasonal air currents which characterize the monsoon climate with summer maritime and winter continental winds.

The coasts of southern Asia are bordered by the warm waters of the Indian Ocean with its typical air masses and winds. Equatorial maritime air and the moist equatorial summer monsoon play a predominant role here. Their effect, however, decreases progressively in southwestern Asia, where tropical continental air predominates, resulting in the development of desert landscapes.

In spite of its irregular and very dissected coastline, the continent has a massive form, with large inland areas far from maritime influences. There are many desertic and rainless regions in these inland areas, partly owing to the relief of closed high plateaus surrounded by mountain ranges.

The orography of Asia is characterized by large, high mountain systems in the central and western sectors. A continuous mountain belt stretches from west to east through the southern part of the continent. These mountain systems contrast sharply with lowlands which occupy very large areas. The average elevation of the continent is about 950 metres above sea level, the highest in the world.

As a result, the Asian continent consists of several broad, distinct regions. These are northern Asia (Siberia); middle Asia (the Turan plain and surrounding mountains); central Asia, with the world's highest mountain ranges and high desert plateaus; western Asia, where there are many dry plateaus, but at lower altitudes; eastern Asia, with a varied relief of mountains and low plateaus with irregular marine coastal plains and groups of islands; and southern Asia, consisting mostly of peninsulas and islands where moist monsoon and equatorial climates predominate.

CLIMATE

Climatic factors

The main characteristics of the climates of North and Central Asia are determined by the continent's geographical position and its enormous size. The largest part of it lies within the temperate and subtropical regions; high mountains and plateaus predominate in the southern part. During winter the continent (with the exception of the tropical regions) cools strongly and a high-pressure zone (the Asian winter anticyclone) forms. The central part of the anticyclone embraces the Mongolian region and southeastern Siberia. The mean air pressure at sea level may reach 1 036 mb in January. The polar continental air mass predominates over the largest part of Asia during winter and the polar front moves to the southern ranges of the great mountain belt.

The winter anticyclone forms not only because of the strong cooling of the land mass, but also as a result of general atmospheric circulation and the inflow of descending air masses in the subtropical zone.

In the eastern peripheral region of the winter anticyclone, a strong northwestern flow of cold continental air reaches far to the south and brings cold, dry winters in temperate and subtropical eastern Asia.

In the tropical southern part of the continent the northeast monsoon, with tropical continental air, predominates. As a result, winters are dry, with the exception of the far southeast and the equatorial strip. Generally, there is little precipitation in the winter; only the western part of the subtropical belt with a Mediterranean climate receives winter rains.

The distribution of atmospheric pressure and air currents is determined by changes in temperature; the tropical front moves northward over the southern mountain ranges while the polar front recedes to the north. Low atmospheric pressure predominates over the continent, with the minimum over the driest and hottest part (e.g. the Indus plain and southern Iran), where the mean atmospheric pressure in July is only 997 mb.

In eastern subtropical and temperate Asia, the summer rainy season is caused by regular southeast monsoonal winds coming in from the Pacific Ocean. They are formed by the atmospheric circulation of subtropical anticyclones over the ocean, and by the continental low-pressure zone. In the summer both factors often bring masses of tropical maritime air into eastern Asia. Heavy rains are brought by tropical typhoons which invade the coasts of China and Japan.

The climatic contrasts between different parts of the continent are due to the irregular distribution of rainfall. The highest precipitation falls in southeastern China (up to 2 000 mm in Hainan). In contrast, almost all of western Asia and the high-mountain areas of central Asia are extremely dry; vast desert and semidesert regions receive less than 200 mm of rainfall a year.

The Himalayas sharply separate the humid tropical climate to the south from the cold dry climate of the high-mountain deserts to the north. In eastern China the Ch'in Ling range is an important climatic border line. South of it are the humid subtropical and tropical climates of southern China where rich and varied evergreen forest predominates. North of it the summer is hot, the winter is rather cool, rainfall is lower, and the composition of the vegetation becomes much simpler, consisting partly of steppe and even semidesert types.

A moister, mostly subtropical climate, with a mean annual rainfall of 1 000 to 2 000 mm, characterizes all of Japan except Hokkaido and northern Honshu islands — a climatic regime which favours the development of a rich and varied forest vegetation.

Mongolia, northern and northeastern China, northern Japan and southern Siberia have a temperate climate with a cold winter. The northern part of eastern China, Manchuria, northern Japan and the extreme eastern part of Siberia have a temperate monsoon climate with a rainy summer. In Mongolia the climate is dry and extremely continental with a severe winter and a warm summer. The mean January temperature is -27°C in northern Mongolia, -20°C in northeastern China, -10°C in Peking, and -5°C in Hokkaido. Southern Japan and southern China have mean January temperatures above 0°C which, however, are too low for their geographical latitude; for example, Shanghai, situated at 31°N, has a mean January temperature of only 5°C.

The climates of Siberia and middle Asia are influenced by the Atlantic, Arctic and Pacific oceans and by tropical air masses, and vary greatly from east to west and from north to south. In these regions the polar continental air mass that forms over the continent has a dominant influence. It is dry and has high summer and low winter temperatures. The north Atlantic cyclones bring precipitation as they move east, but rarely pass the Ural mountains.

The arctic air mass influences all the northern part of the U.S.S.R. Low temperature, low humidity and high visibility differentiate it from other air masses. Its role is particularly great in eastern Siberia, where the effect of the Atlantic cyclones is not felt. From time to time, especially during spring and autumn, the arctic air mass moves south, invading the middle and southern latitudes. The phenomenon of May cold snaps, when warm, almost summery weather is interrupted by several cold days, and even by frosts, is connected with these invasions.

The tropical air mass greatly influences the climate of the southern part of the U.S.S.R. However, its influence is felt only during the warm months of the year. A local tropical air mass with high temperatures, low humidity and low visibility forms in the summer over middle Asia, penetrating as far north as the forest zone. In the winter the predominating polar air mass is less cold in middle Asia than in more northerly regions.

In the winter all of the Asian part of the U.S.S.R. except the extreme southern part of middle Asia has below-zero air temperatures. In January the isotherms do not coincide with the geographical latitudes. Because of the warm north Atlantic air current which reaches as far as Lake Baikal, the winter isotherms run from northwest to southeast. The -20°C isotherm appears in the northern Ural region and descends southward in Siberia toward the Sayan and Altai mountains. In eastern and northeastern Siberia, the January -35°C and -40°C isotherms form closed circles. Here, under the influence of the winter anticyclone, an unusually marked cooling of the air occurs. Especially low temperatures are observed in Verkhoyansk and Oimyakon, where the mean January temperature falls to -50°C and the absolute minimum is -68°C. This "pole of cold" is formed by the depressional relief of the area in which cold air accumulates during the anticyclonal winter weather.

In the Far East region of the U.S.S.R. the January isotherms run to the northeast along the coastline as a result of the warming influence of the Pacific Ocean. However, this influence is felt only in a relatively narrow coastal strip. For example, at Okhotsk, which is only 200 km from the ocean, the January isotherm is -40°C, rather than -20°C at the coast. Such a limited influence of the ocean on the winter temperature regime of the Far East region is connected both with the mountainous relief of the area, and with the winter monsoon blowing from the cold continent toward the ocean.

In the summer, air temperatures are above zero in all parts of northern Asia except the high-mountain regions. In contrast to the January isotherms, the July isotherms run approximately along the latitudes because the Atlantic and Pacific oceans are cooler in the summer than the inland regions of the continent. The coldest regions are the Arctic islands, where the mean July temperature is near 0°C. The hottest region is in southern middle Asia, with a mean July temperature of 32°C and an absolute maximum of 50°C. The frostless period varies from 45 to 60 days in the Siberian tundra, and from 270 to 300 days in middle Asia. The number of warm summer days with a mean daily temperature above 15°C does not exceed 10 to 15 a year in the tundra, but increases to as many as 180 to 200 in southern Turkmenia.

Climatic regions

Figure 1 presents the climatic regions of North and Central Asia according to the system of J. Papadakis (1966).

The type of cropping in a region is to a large degree determined by its climate. However, many climatic classifications fail to show the relationships between climatic regions and their agriculture because they do not take into consideration such important climatic features as winter severity, duration of the frost-free season, potential evapotranspiration, and humid and dry seasons. Moreover, most climatic classification systems, e.g. those of D.L. Armand (1956), W. Köppen (1936), L.D. Stamp (1948) and C.W. Thornthwaite (1948), have been based on a correlation between climate and natural vegetation, and do not take into consideration the climatic characteristics of various crops. Hence the Papadakis climatic classification system was selected for the Soil Map of the World. The criteria and climatic limits used have been fixed with crop requirements in mind so that the climatic regions outlined are of significance to agriculture.

Each climatic region shown on the map is represented by a number. Table 2 gives the key to these numbers and the main locations of their occurrence. Table 3 gives the climatic characteristics of representative sites in the various regions. A special key to the symbols used in Tables 2 and 3 is also given, but for their exact definitions Papadakis (1961, 1966) should be consulted.

Of the ten main climatic types recognized in the Papadakis classification, nine (with the exception of the Pampean climate) are extensive in North and Central Asia. These are:

1. Tropical (1.2, 1.6)

The fundamental feature of tropical climates is the absence of frosts; average lowest monthly temperatures are above 7°C all year round. Hence perennial crops very sensitive to frost can be grown, and summer crops can be grown all year round. However, the winter is too warm for cryophilous crops.

These climates occur only in a small part of the extreme southeast of the area under consideration.

2. Tierra fria (2.1, 2.3)

These are climates of non-frostless tropical highlands, and so crops very sensitive to frost cannot be grown. Depending on the altitude, the crops that can be grown vary from cotton to potatoes, and at very high altitudes even potatoes cannot be grown.

Tierra fría climates occupy extensive areas in the Shan plateau and in the Nan Ling mountains and Yunnan province in southern China.

3. Desert (3.71a, 3.71b, 3.71c, 3.72a, 3.72b, 3.72c, 3.73)

Cropping cannot be done under these climates without irrigation, but the deserts provide some grazing in the winter. With irrigation various crops can be grown according to the temperature regime. The low rainfall is often an advantage, for when water is available for irrigation, water management can be carefully controlled according to crop requirements. Hence various types of agriculture are found in the desert oases of middle Asia.

Desert climates extend over large areas in middle and central Asia from the Turan plain to the Tibetan highlands, including the Tarim river basin, the Takla

TABLE 2. – KEY TO CLIMATIC MAP OF NORTH AND CENTRAL ASIA (FIGURE 1)

Map symbol	Climate	Temperature regimes	Humidity regimes	Main locations
1.2	Humid semihot tropical	Tr	Hu, MO	Eastern Taiwan, Hainan and south coast of China
1.6	Humid cool tropical	tr	HU, Hu	Southeastern coastal strip, China
2.1	Monsoon semitropical tierra fría	TF	MO, Mo	Kweichow, China
2.3	Monsoon medium tierra fría	Tf	MO	Southern Yunnan, China
3.71a	Mediterranean warm continental desert	CO	de	Turkmenia, U.S.S.R.
3.71b	Isohygrous warm continental desert	CO	di	Kazakhstan, U.S.S.R.
3.71c	Absolute warm continental desert	CO	da	Central Asian deserts
3.72a	Mediterranean semiwarm continental desert	Co	de	Northern Kazakhstan, U.S.S.R.
3.72b	Absolute semiwarm continental desert	Co	da	Mongolia
3.72c	Monsoon semiwarm continental desert	Co	do	Inner Mongolia, China
3.73	Cold continental desert	co, te	da, do	Tibet, China
4.1a	Humid semihot subtropical	Su	HU, Hu	Western Taiwan, China
4.1b	Humid semihot subtropical	Su	Hu	Southeastern China
4.1c	Humid semihot subtropical	Su	Hu	Chungking plain, China
4.2	Monsoon hot subtropical	Su, SU	MO, Mo, mo	Southern China; southern Himalayas
6.78	Dry semiwarm continental Mediterranean	Co	Me, ME	Uzbekistan, U.S.S.R.
6.9	Semiarid warm continental Mediterranean	CO	me	Southern Turkmenia, U.S.S.R.
7.6a	Humid cool temperate marine	Te	HU, Hu	Khanka plain, U.S.S.R.
7.6b	Humid cool temperate marine	Te	HU, Hu	Hokkaido, Japan
7.7	Humid cold temperate marine	te	HU	Southern tip of Sakhalin Island, U.S.S.R.
8.1a	Humid warm continental	CO	HU, Hu	Southeastern China
8.1b	Humid warm continental	CO	HU, Hu	Republic of Korea
8.1c	Humid warm continental	CO	Hu, HU	Southern Japan
8.2a	Humid semiwarm continental	Co	Hu, HU	Dem. People's Rep. of Korea
8.2b	Humid semiwarm continental	Co	Hu, HU	Northern Honshu, Japan
8.2c	Monsoon semiwarm continental	Co	MO	Manchuria, China
8.3a	Humid cold continental	co	Hu	Southwestern Siberia, U.S.S.R.
8.3b	Humid cold continental	co	Hu	Far East region, U.S.S.R.; northeastern China
9.33	Monsoon cold steppe	co	Mo	Northern Kazakhstan, U.S.S.R.
9.35	Monsoon cold steppe	co	Mo	Southern Siberia, U.S.S.R.
9.73	Semiarid cold continental steppe	co	si	Kazakhstan, U.S.S.R.; western Mongolia
9.81	Monsoon cold continental steppe	co	Mo	Northern Mongolia; western Manchuria, China
9.82	Monsoon semiwarm continental steppe	Co	Mo	Northern Manchuria, China
9.87	Monsoon warm continental steppe	CO	Mo	Shantung, China
9.88	Monsoon warm continental steppe	CO	mo	Shensi, China
10.11	Ever-humid taiga	Po	HU	Western Siberia, U.S.S.R.
10.12	Humid taiga	Po	Hu	Far East region, U.S.S.R.
10.14	Dry monsoon taiga	Po	Mo	Eastern Siberia, U.S.S.R.
10.17	Humid taiga	Po	Hu, Mo	Northern central Siberia, U.S.S.R.
10.19	Steppe taiga	Po	St	Central Siberia
10.2	Humid tundra	po	Hu	Northern Siberia, Chukotski Peninsula, U.S.S.R.
10.3	Subglacial desert	Fr	Hu, MO	Northern Siberia, Taimyr Peninsula, U.S.S.R.
10.5	Polar-alpine	al	Hu, HU	Tien Shan ranges

SOURCE: Papadakis, 1966.

TABLE 3. – CLIMATIC CHARACTERISTICS OF SOME PLACES REPRESENTING THE CLIMATIC REGIONS OF NORTH AND CENTRAL ASIA

Map symbol	Climate[1]	Place	Temperature regime	Winter type	Summer type	Humidity regime	Humidity index[2]	Annual potential evapotranspiration[3] (mm)	Annual rainfall (mm)	Leaching rainfall[4] (mm)	Drought stress[5] (mm)	Humid season[6]	Dry season[6]
1.2	1.22	Haulienk'ang	Tr	Tp	g	Hu	2.29	850	1 950	1 120	20	1–11	0
1.2	1.24	Hengch'un	Tr	Tp	g	MO	2.16	990	2 140	1 450	300	5–10	1–3
1.6	1.62	Amoy	tr	tp	g	Hu	1.57	750	1 180	530	100	2–9	0
2.1	2.12	Hsi-ch'ang	TF	Ci	c	MO	1.06	1 140	1 210	510	440	6–10	1–4
2.1	2.14	Meng-tzu	TF	Ci	c	Mo	0.76	1 270	970	190	490	6–9	1–4
2.3	2.32	K'un-ming	Tf	Ci	M	MO	1.08	940	1 020	440	360	5–10	2–4
3.71a	3.71	Krasnovodsk	CO	Ti	g	de	0.14	980	140	0	840	0	4–12
3.71b	3.71	Guryev	CO	Pr	c	di	0.20	780	160	10	630	12–1	4–10
3.71c	3.71	Kashgar	CO	Ti	g	da	0.07	1 120	80	0	1 040	0	11–10
3.72a	3.72	Kazalinsk	Co	Pr	M	de	0.11	1 120	120	0	1 000	0	1–12
3.72b	3.72	Kucha	Co	ti	M	da	0.07	1 240	90	0	1 150	0	12–11
3.72c	3.72	Chiu-ch'üan	Co	ti	M	do	0.09	810	70	0	740	0	11–10
3.73	3.73	Leh	te	ti	t	do	0.10	870	90	0	780	0	9–8
4.1a	4.11	Taipei	Su	Ci	g	HU	2.18	920	2 010	1 060	0	1–12	0
4.1b	4.121	Canton	Su	Ci	g	Hu	1.75	950	1 660	820	110	2–9	0
4.1c	4.121	Lung-chou	Su	Ci	g	Hu	1.59	820	1 300	580	100	4–9	0
6.78	6.78	Tashkent	Co	Ti	M	Me	0.32	1 190	380	60	870	12–3	6–10
7.6a	7.62	Vladivostok	Te	ti	T	HU	1.95	320	620	290	0	5–4	0
7.6b	7.61	Hakodate	Te	Ti	T	HU	2.73	440	1 200	760	0	7–6	0
7.6b	7.62	Nemuro	Te	ti	T	HU	3.40	300	1 020	730	10	9–8	0
7.6b	7.65	Sapporo	Te	ti	T	Hu	2.20	520	1 140	620	0	7–5	0
7.7	7.71	Nevelsk	te	ti	t	HU	2.76	270	750	490	10	5–4	0
8.1a	8.11	Wu-na-mu	CO	av	g	HU	1.63	720	1 170	450	0	10–9	0
8.1a	8.12	Shanghai	CO	av	g	Hu	1.36	860	1 170	340	30	1–10	0
8.1a	8.15	Ch'ang-sha	CO	av	G	Hu	1.63	810	1 320	590	80	10–6	0
8.1b	8.11	Kangnung	CO	Ti	g	HU	1.71	720	1 230	540	30	11–10	0
8.1b	8.15	Seoul	CO	Ti	g	Hu	1.89	670	1 270	610	10	11–9	0
8.1c	8.11	Kumamoto	CO	av	g	HU	2.12	860	1 820	890	0	11–10	0
8.1c	8.12	Yamagata	CO	Ti	c	Hu	2.26	660	1 490	590	0	6–4	0
8.1c	8.13	Kobe	CO	av	g	Hu	1.66	780	1 430	520	0	9–7	0
8.2a	8.21	Wonsan	Co	Ti	M	HU	2.29	580	1 330	760	10	1–12	0
8.2a	8.23	Dairen	Co	ti	M	Hu	1.02	600	610	190	180	7–9	0
8.2b	8.21	Aomori	Co	Ti	M	HU	3.06	450	1 380	960	30	6–5	0
8.2b	8.23	Mito	Co	Ti	M	Hu	2.11	660	1 390	740	10	2–12	0
8.2c	8.26	Mukden	Co	ti	M	MO	0.91	770	700	120	50	7–8	0
8.3a	8.32	Sverdlovsk	co	Pr	t	Hu	1.22	350	430	90	10	6–2	0
8.3b	8.32	Khabarovsk	co	pr	T	Hu	1.45	340	490	180	30	5–1	0
9.3a	9.33	Tselinograd	co	Pr	t	Mo	0.49	610	300	50	360	10–3	6–9
9.3b	9.35	Tomsk	co	pr	t	Mo	0.77	370	280	50	140	9–2	6
9.73	9.73	Kokpekty	co	Pr	t	si	0.34	800	350	50	500	11–2	5–9
9.81	9.81	Ulan Bator	co	pr	t	Mo	0.48	430	210	0	220	7	9–5
9.82	9.82	Harbin	Co	Pr	M	Mo	0.80	610	490	40	160	7–8	2–5
9.87	9.87	Tsinan	CO	Ti	g	Mo	0.59	1 080	640	110	550	7–8	11–6
9.88	9.88	Sian	CO	Ti	G	mo	0.43	1 120	480	0	640	0	11–6
10.11	10.11	Salekhard	Po	pr	P	HU	1.67	160	270	100	0	8–7	0
10.12	10.12	Okhotsk	Po	pr	P	Hu	1.89	160	300	150	10	5–1	0
10.14	10.14	Irkutsk	Po	Pr	P	Mo	0.84	450	380	300	370	8;11–2	0
10.19	10.10	Vilyuisk	Po	pr	P	St	0.56	400	220	40	220	9–3	6–7
10.2	10.22	Anadyr	po	pr	p	Hu	1.22	150	180	40	10	8–3	0
10.3	10.3	Wrangel Is.	Fr	pr	F	Hu	1.45	70	100	40	10	7–4	0

[1] Meteorological definitions of the numbers and their agricultural potentialities are given in Papadakis (1966). – [2] An annual humidity index representing the ratio of annual rainfall/annual evapotranspiration (Papadakis, 1961). – [3] Computed month by month on the basis of midday saturation deficit (Papadakis, 1961). – [4] Rainfall minus potential evapotranspiration during the humid season. – [5] Potential evapotranspiration minus rainfall during the non-dry season. – [6] A month is *humid* when rainfall exceeds potential evapotranspiration, it is *dry* when rainfall plus the water stored in the soil from previous rains covers less than half of potential evapotranspiration, and *intermediate* between these. *11-10 means that the season begins with* November (11) and terminates with October (10); both November and October are included, so it covers the whole year. 0 means that there is no such season. Months not mentioned in the humid or dry season are intermediate.

KEY TO SYMBOLS IN TABLES 2 AND 3

Temperature regimes [1]

Tr	Semihot tropical
tr	Cool tropical
TF	Low tierra fría
Tf	Medium tierra fría
SU	Hot subtropical
Su	Semihot subtropical
Te	Cool temperate
te	Cold temperate
CO	Warm continental
Co	Semiwarm continental
co	Cold continental
Po	Taiga polar
po	Tundra polar
Fr	Subglacial desert polar
al	High alpine

Humidity regimes [1]

HU	Ever-humid
Hu	Humid
ME	Moist Mediterranean
Me	Dry Mediterranean
me	Semiarid Mediterranean
MO	Moist monsoon
Mo	Dry monsoon
mo	Semiarid monsoon
St	Steppe
da	Absolute desert
de	Mediterranean desert
di	Isohygrous desert
do	Monsoon desert
si	Semiarid isohygrous

Winter types [1]

Tp	Tropical frostless, but too cool for equatorial crops (rubber, coconut) and too warm for cryophilous crops (wheat)
tp	*Idem*, but wheat is not entirely excluded
Ci	Non-frostless, sufficiently mild for citrus and sufficiently cool for cryophilous crops
av	Cool, but sufficiently mild for winter oats
Ti	Sufficiently mild for winter wheat, but not for winter oats
ti	*Idem*, but winter days are cooler
Pr	Insufficiently mild for winter wheat; virtually all crops are sown in spring
pr	*Idem*, but spring days are cooler

Summer types [1]

G	Sufficiently warm for cotton, summer days are very hot
g	*Idem*, but summer days are less hot; it cannot be *c*
c	Sufficiently warm for maize and cotton, summer days are not so warm, nights are cool but frostless all year round
M	Cooler, sufficiently warm for maize, but not for rice
T	Cooler, sufficiently warm for wheat
t	*Idem*, but the frost-free season is shorter
P	Cooler, but sufficiently warm for forest
p	*Idem*, but insufficiently long and warm for forest and grassland and sufficiently warm for tundra
F	Insufficiently long and warm for tundra but not continuously covered by ice

[1] For the corresponding definitions, see Papadakis (1961, 1966).

Makan and Gobi deserts, and the Tsaidam depression. This is the " desert heart " of Asia protected by high mountains and remoteness from Arctic and Pacific maritime influences. The environment varies greatly from the desert steppe of the Altai mountain system and Mongolia to extensive semidesert areas and absolute stony and sandy deserts such as the Takla Makan and the cold montane deserts of Tibet.

4. SUBTROPICAL (4.1a, 4.1b, 4.1c, 4.2)

These climates are characterized by mild winters and long warm summers, and summer crops such as cotton, rice, maize, sorghum, groundnuts and tobacco are widely grown, the choice depending on the humidity regime. Some of them have winters cool enough for wheat and other cryophilous crops, but others are too warm for wheat, which, if grown, is only marginal.

Subtropical climates characterize southern China and the southern Himalayas.

6. MEDITERRANEAN (6.78, 6.9)

These climates have dry summers and more or less humid winters; hence winter cereals, legumes, grapes, olives, figs and almonds are the principal rainfed crops.

In middle Asia the Mediterranean-type climate is rather dry. It occurs only in southern Turkmenia and Uzbekistan in the U.S.S.R., and in the piedmont desert steppe zone of the western Tien Shan, Gissar and Kopet Dag mountains.

7. MARINE (7.6a, 7.6b, 7.7)

These climates have cool summers and relatively mild winters, and cryophilous crops such as wheat, peas, flax, apples, peaches and clover are raised. Since the climate is humid, reasonably fertile soils provide abundant grazing during much of the year. Conditions are also very good for forest.

These climates occur only in a small part of the eastern U.S.S.R., the southern tip of Sakhalin Island, the Kuril Islands and northern Japan.

8. HUMID CONTINENTAL (8.1a, 8.1b, 8.1c, 8.2a, 8.2b, 8.2c, 8.3a, 8.3b)

These climates are as humid as the marine climates, but winters are cold and summers more or less warm. They are good for grassland agriculture, but less so than the corresponding marine climates, and they are better for annual crops. Cotton is important in 8.1, maize in 8.2, and wheat and other cryophilous crops in 8.3.

Humid warm continental climates occur in southeastern China, southern and central Japan, and the Republic of Korea, and Manchuria and the Democratic People's Republic of Korea have humid semiwarm continental climates. Humid cold continental climates characterize the southern part of Sakhalin Island, the Far East region of the U.S.S.R., and the forest-steppe zone of western Siberia.

9. STEPPE (9.33, 9.35, 9.73, 9.81, 9.82, 9.87, 9.88)

These climates are more or less dry, and winters are cold. Crops vary from cotton to sorghum, maize and wheat according to summer temperatures. The dry weather allows crops to be harvested under good conditions, and weeds are not a problem. Soils under these climates are also better than those in more humid conditions. Grassland agriculture is important.

Cold steppe climates in southern Siberia and northern Kazakhstan coincide with the main Chernozem belt of western Siberia and the Altai region, and semiarid cold continental climates occur in the Kastanozem belt to the south. Monsoon continental steppe climates characterize the Mongolian steppes and central and northeastern China.

10. POLAR-ALPINE (10.11, 10.12, 10.14, 10.17, 10.19, 10.2, 10.3, 10.5)

These climates are almost too cold for crops. Forestry and grassland agriculture are important in the warmer areas. Most agriculture is limited to river valleys.

The taiga subtypes of these climates characterize the great taiga belt of northern Asia. In eastern Siberia agricultural conditions are especially severe owing to the presence of permafrost at various depths. There are great variations within the taiga climatic belt from north to south and from west to east. The climatic conditions in western Siberia are milder than in eastern Siberia, and along the Pacific coast they are not as severe as in central Siberia. Tundra climates occur in northern Siberia and the Chukotski and Kamchatka peninsulas. Further north, subglacial desert climates occur along the Arctic coast. Alpine climates are shown as a separate region in the central Tien Shan ranges; they occur in numerous other central Asian mountain systems, but only locally at high altitudes.

VEGETATION

General characteristics

The vegetation of North and Central Asia is extremely rich, complex and diversified. The continent may be subdivided into two main groups of floristic regions: paleotropic and holarctic. With the notable exception of southern China, most of the area under consideration belongs to the holarctic group.

Southern China, South Asia and Southeast Asia are sometimes grouped in one large paleotropic Indo-Malayic region which includes India, Indochina and Indonesia. Another classification system subdivides this region into the Malaysian region (Indonesia and Malacca) and the Indian region (India, Indochina and southern China). In any case, southern China, including Hainan, Taiwan and the southern China coastal strip, belongs to the paleotropic group, which is floristically quite different from the rest of the continent. Tropical evergreen rain forest of very complex composition is the main vegetation type here.

On the southern slopes of the Himalayas and in the mountains of southern China the vegetation has a prominent altitudinal zonality. Wet tropical forest occurs up to an altitude of about 1 000 metres. At a higher elevation subtropical trees (evergreen oaks) and some conifers are found in association with tropical trees. Above 2 000 metres tropical trees disappear, the proportion of conifers increases, and broadleaf deciduous trees begin to appear. Thickets of Himalayan rhododendrons (*Rhododendron arboreum*, *R. campanulatum*) are common in this high forest zone. The forest disappears at an elevation of about 3 500 metres, above which is a zone of high-mountain (subalpine and alpine) shrub and meadow. A large number of plant species, especially tree species, occur in the region.

The remainder of North and Central Asia belongs to the large holarctic group, in which the broad eastern Asian, central Asian, "Mediterranean," Euro-Siberian and arctic floristic regions can be distinguished.

Of these regions, eastern Asia has the most ancient, rich and diversified vegetation forms. This region includes eastern and northeastern China and Japan, and to the south is closely connected with the Indian paleotropic region, for which reason numerous tropical trees are found in southern China and even southern Japan. However, its most characteristic forest vegetation comprises subtropical evergreen forest (evergreen oaks, camelias, etc.), broadleaf forest with many deciduous tree species, and coniferous forest with many Chinese and Japanese tree species, several of which are relict. These three types of forest vegetation in the mountain regions of China and Japan often form altitudinal zones and several mixed formations. Widely occurring broadleaf trees are eastern Asian species of *Carpinus*, *Quercus*, *Fagus*, *Acer*, *Fraxinus*, *Alnus*, chestnuts, hazelnuts, and relict species of *Pterocaria*, *Ostrya* and *Ostryopsis*. In all, Chinese flora includes as many as 260 genera of broadleaf trees. Of the coniferous trees, the *Pinus*, *Abies*, *Picea*, *Cryptomeria* and *Thuja* species are numerous. In general, this forest is of dense and varied composition, and occurs in the mountains of Japan and in a large area of eastern China.

In contrast, the forest vegetation of the central Asian floristic region is very poor. Scattered forests occur on mountain slopes and in river valleys in northern Mongolia and southeastern Tibet. Sparse and extremely poor grass and xerophytic semishrub vegetation characterizes central Asia. Several species of *Artemisia* and halophytes grow in the region. Saxaul and shrub legumes such as *Astragalus*, *Oxytropsis* and *Cargana* occur in Mongolia, and semispherical clumps of *Cargana pygmaea* and coarse Tibetan sedge (*Cobresia tibetica*) are found in Tibet. Tibetan flora comprises very few species, and in origin and composition it is more similar to the flora of the China-Himalaya region than to that of the rest of central Asia.

The " Mediterranean " region, which mainly comprises the countries of the Near East, greatly influences middle Asia, making its flora somewhat transitional between Mediterranean and central Asian. The flora of the middle Asian deserts is often classified as Mediterranean, whereas the flora of the surrounding semideserts is considered central Asian. In any case, the vegetation of middle Asia as a whole comprises elements of both Mediterranean and central Asian florae appearing separately or in association.

The Euro-Siberian floristic region comprises the steppe and forest belts of Siberia from the Urals to the Kamchatka Peninsula. As it is so large, it includes various plant species in different subregions which change from west to east. For instance, the principal forest tree of eastern Siberia is the Dahurian larch (*Larix dahurica*), and in western Siberia it is the Siberian larch (*L. sibirica*). Siberian stone pine (*Pinus sibirica*) occurs widely in western and southeastern Siberian taiga forest, whereas Siberian and European spruce (*Picea obovata*, *P. excelsa*) and Scotch pine (*Pinus silvestris*) are more important in northern taiga forest. The steppes of this floristic region are richer in species, and plant cover composition shows some variation from west to east.

The arctic region includes the tundra and forest-tundra zones of northern Siberia. Conditions unfavourable to vegetation in the tundra are the short growing season, low summer temperatures, the drying action of constant winds, and the presence of a shallow permafrost — all of which explain the paucity of plant species in the region, their slow growth, their remarkable ability to endure frosts, and the predominance of low bushes and perennial grasses.

The broad vegetation regions

The natural plant cover of North and Central Asia may be divided into 11 broad vegetation regions and 39 vegetation regions. These regions are distinguished on the basis of the habitat (either climatic or edaphic), and of the physiognomy and structure of the vegetation.

Figure 2 shows the vegetation regions listed below.

1. Arctic wastes

2. Tundra
   - 2a. Arctic tundra
   - 2b. Moss, lichen and dwarf shrub tundra
   - 2c. *Carex-Eriophorum* hummocky tundra
   - 2d. Scrub tundra
   - 2e. Montane tundra and open vegetation of the northern mountains

3. Taiga forest
   - 3a. Forest-tundra
   - 3b. Dark coniferous and pine taiga forest
   - 3c. Larch-pine taiga forest
   - 3d. Larch forest
   - 3e. Montane dark coniferous taiga forest
   - 3f. Montane dark coniferous taiga forest and montane larch and pine-larch forest
   - 3g. Montane larch and pine-larch forest
   - 3h. Montane open larch forest and montane tundra
   - 3i. Montane pine forest

4. Temperate deciduous small-leaf forest
   - 4a. Western Siberian aspen-birch forest
   - 4b. Pacific birch open forest and grassland

5. Temperate deciduous broadleaf forest
   - 5a. Temperate deciduous broadleaf forest
   - 5b. Montane temperate broadleaf-coniferous forest

6. Subtropical and tropical forests
   - 6a. Tropical evergreen rain forest
   - 6b. Subtropical evergreen rain forest
   - 6c. Subtropical deciduous forest
   - 6d. Subtropical xerophilous evergreen hardleaf forest
   - 6e. Subtropical montane pine forest
7. Meadow steppe
   - 7a. Meadow steppe with oak forest
   - 7b. Meadow steppe with birch forest
8. Steppe
   - 8a. Feather grass-fescue Kazakhstan steppe
   - 8b. Feather grass-fescue central Asian steppe
   - 8c. Fescue-tansy eastern Siberian steppe
   - 8d. Semishrub-grass Kazakhstan desert steppe
   - 8e. Semishrub-grass central Asian desert steppe
   - 8f. Semisavanna
   - 8g. Montane steppe and montane forest-steppe
9. Desert
   - 9a. Semishrub Turan desert
   - 9b. Semishrub central Asian desert
   - 9c. Saxaul sandy desert
   - 9d. Shifting sand desert
   - 9e. Stony and gravelly desert
   - 9f. Halophytic desert
   - 9g. High-mountain desert
10. Subalpine and alpine meadows
11. Arable land with unknown natural vegetation

The above vegation regions constitute only a very broad grouping of the plant cover. Each of them could be subdivided into small uniform subunits corresponding to local edaphic or climatic conditions.

1. Arctic wastes

The arctic wastes occupy the numerous Arctic islands and the mountains of the Taimyr Peninsula. The abundance of ice on the land and in the adjacent sea, and the cooling of the lower layers of air (from the absorption of heat in the thawing ice) result in a severe polar climate. A feature of this climate is the change from the short period of continuous insolation during the polar summer to the period of absence of solar heat during the long polar winter. The temperature regime is very severe and greatly enhances frost weathering. The normal daily changes of air temperature cease during the long polar night. During winter there are about 100 days of snowstorms, concentrated mostly in January. Snow cover is established at the end of September and lasts until the beginning of July.

The short, cool summer limits the number of plant species. The soil cover is poorly developed, and in many places is replaced by a gravelly, rubbly eluvial layer without continuous sod cover. Grass species grow in clumps separated by areas of bare rock, a few of which are covered by mosses and lichens. Conspicuous in drier places are saxifrage (*Saxifraga caespitosa*, *S. hirculus*), cinquefoil (*Potentilla fragiformis*) in very dense clumps, arctic poppy (*Papaver radicatum*), *Luzula hyperborea*, and glacial avens (*Sieversia glacialis*). Grass clumps, among which grow most of the mosses and lichens, are more abundant on moister places along the slopes. Oxalidaceae (*Oxyria digyna*) are found on sandy or rubbly hills, and crowfoot (*Ranunculus nivalis*) near patches of snow. In general, the vegetation pattern resembles that of alpine high-mountain deserts elsewhere.

Very open vegetative cover (where plants cover no more than 50 percent of the surface) is a characteristic of the arctic wastes, and distribution of the vegetation, which occurs mostly under various protective covers, is rather irregular. Areas subject to snow corrosion are vegetationless.

The arctic wastes are represented by three botanical groups whose zonality is not well defined. In the extreme north, a waste with grasses and mosses including several flowering species occurs. Further south, mainly in the New Siberian Islands, there is an impoverished waste of semishrubs and mosses. A waste of mosses and numerous shrub species is found still further south, especially in the Taimyr Peninsula. From west to east the ecological conditions in the arctic wastes improve, and their flora becomes richer and more diversified.

Mossy marsh meadow and floodland meadow occur in river valleys and deltas.

The frosts cause cracking which breaks the ground surface into polygons. The cracks gradually become depressions in which vegetation is confined. The surface of the polygons is covered by blue-green algae and inconspicuous lichens and mosses. In the northernmost parts of the arctic wastes low humidity reduces cracking, and the vegetation grows scattered in minute cracks all over the surface.

On stony and gravelly terrain and moraines, the breaking of stones by the cold creates landscapes with stony rings, hollows, nets, flows and polygons. The typical polygonal structures of the southern floodlands represent a system of transecting elongated depressions which enclose small swamps or lakes.

The poor vegetation of the arctic wastes can nourish a large population of lemmings, which are the main food for the valuable polar fox, and also very limited herds of reindeer. In the southern arctic wastes the total supply of green plant mass is about 0.6 t/ha and the annual yield is about 0.4 t/ha.

The broad region of arctic wastes is not subdivided here into smaller units, as it is of very low agricultural importance and has not yet been fully studied.

2. Tundra

Tundra occurs in a narrow northern coastal strip which widens in places to extend southward to the mountains.

Tundra vegetation comprises primarily mosses, lichens and semishrubs. As the cold climate does not favour plant growth, plants grow close to the ground in order to utilize all available heat from the upper soil horizon and the lower air layers, and in so doing acquire the pillow-like and spreading forms typical of flora in this vegetation region.

Tundra plants are mostly perennial, and many (e.g. *Vaccinium vitis idaea, Oxycoccus quadripetalus, Cassandra* sp. and *Ledum palustre*) are evergreen. Despite the excess moisture always present in the soil and the high humidity of the climate, tundra plants are xerophytic because the water in the soil is often so cold that they cannot utilize it.

The tundra has no forest vegetation, and the severe climate (low air temperature, high air humidity, strong winds) is generally considered to be the cause of this phenomenon.

The tundra regions are:

2a. *Arctic tundra*

Arctic tundra occurs in narrow strips along the Arctic coast. In this region soil-forming processes are weak, scrub and peat swamps are absent, and there is a broad development of polygonal tundra. Arctic soils are characterized by physical weathering, weak biochemical processes, leaching, weak activity of microorganisms, slow accumulation of peat and rough humus, and weak gleyification. The loamy soils crack into polygonal blocks, and areas of mottled arctic tundra are separated by extensive bare areas. The hardiest arctic grass varieties — foxtail grass (*Alopecurus alpinus*) and sourgrass (*Oxyria digyna*) — grow along frosty cracks. There are neither lichens nor hummocky tundra in this region. Open grass-moss and semishrub (*Dryas* sp., *Salix polaris*, etc.) associations predominate throughout the area. The sparse vegetation results in a paucity of fauna, and only along the sea coast are there many birds.

Arctic tundra provides good summer grazing for reindeer, especially as the coastal strips are almost completely free of mosquitoes. The best grazing is afforded by reindeer moss. The total supply of green plant mass is about 1.2 t/ha and the annual yield is nearly 0.7 t/ha.

2b. *Moss, lichen and dwarf shrub tundra*

Peat-gley and gley soils support this mainly mossy and lichenous tundra, which has bogs but no trees.

Mossy tundra on clay soils has a uniform aspect resulting from the continuous shallow cover of bryophytes, which also includes a few lichens. The comparatively rare shrubs consist mostly of fine viny dwarf birch (*Betula nana*) and some shrub willow (*Salix pulchra*). The vegetative cover comprises more than two dozen species, of which the most common are the arctic tufted plant (*Dryas octopetala*), meadow grass (*Poa arctica*), black crowberry (*Empetrum nigrum*), cotton grass (*Eriophorum vaginatum*), reedgrass (*Carix rigida*) and several cereals.

In the spring, deer graze on moss and cotton grass shoots and in the summer they eat the foliage of shrubs as well. If the grazing is light only the leaves of the shrubs are consumed, benefiting the lichen cover, which is thus exposed to light. Heavier grazing results in the degradation of shrubs, lichens and bryophytes, and a stronger growth of herbs and grasses.

At the base of hills, where snowdrifts pile up on the peat soils during winter, there is a thick overgrowth of polar willows (*Salix glauca, S. lanata, S. pulchra*) and dwarf birch.

In flat low places between hills, monotonous *Hypnum* bogs occur on shallow peat over permafrost. Unlike the swamps of the forest zone, these tundra bogs are flooded in the spring and fall and have a thin turf owing to the low temperature. This produces different kinds of peat with intensive mineralization. Arctic bog moss (*Sphagnum lenense*) yields to bryophyte cover owing to the mineralization of swamp water which accumulates in hollows with impervious bottoms.

Mottled tundra grows on slopes that are bare of snow in winter, and along saddles between hills where there are patches of loam 1 to 3 metres in diameter, separated by narrow strips of vegetation along frosty cracks. There are more lichens and flowering plants than in mossy tundra, as they are more able than bryophytes to adapt to the relative dryness of the soil and the sharp fluctuations of soil temperature that result from the thin snow cover and sparse vegetation.

On raised dry places with clay soils and large sandy hilly areas there is lichenous tundra with dominant fruticose lichens, i.e. *Alectoria, Cetraria*, and reindeer moss (*Cladonia rangiferina*), and a few bryophytes, but almost no grass or shrubs. This type of tundra provides good winter pasture, and although excessive grazing is harmful to the slow-growing reindeer moss, it is advantageous for unpalatable lichens, particularly those which, like *Cetraria*, are able to withstand trampling.

On the well-warmed southern slopes of ravines, along the edges of snow drifts, which often survive the summer, the vegetation is well protected in winter by snow. The abundant moisture and good drainage produce tundra meadows that resemble variegated flower beds on the monotonous green-brown mossy tundra. There are no bryophytes and lichens, and grass forms a thick, short, continuous cover containing a rich and diverse blend of dicotyledons such as crowfoot (*Ranunculus borealis*), globeflower (*Trollius asiaticus*) and valerian (*Valeriana capitata*). The succulent green grassy vegetation reminds one of alpine meadows in mountain regions, and provides good autumn pasture for reindeer.

In narrow strips along rivers and streams, thickets of willow which grow to about the height of a man are frequented by deer. In places there are swampy meadows containing sedge and grasses as well as many dicotyledons.

Thus, the wide variety of ecological conditions in typical tundra results in an equally wide variety of plant associations. The resultant complex plant cover of the area produces the soil cover mosaic typical of this tundra subregion.

2c. Carex-Eriophorum *hummocky tundra*

This type of tundra represents an eastern (mostly east of the Kolyma river) variant of typical tundra. The region occupies the south coast of Chaun Bay, the northeastern part of the Chukotski Peninsula, and broad depressions in the basins of the Anadyr and Penzhina rivers.

Sedge-cotton grass hummocky tundra occupies the region's vast plains, and gentle slopes up to an altitude of about 200 metres. Hummocks occupy from 40 to 70 percent of the area. This tundra type develops in areas where the soil under vegetation thaws in the summer to depths of at least 40 to 60 cm. Bare spots outcrop in places between the sedge and cotton grass as a result of frost action and degradation of hummocks. But mottled tundra is rare here.

A narrow strip of scrub tundra with black crowberry and a few *Sphaghum* bogs occurs along the sea coast. There are some meadows along the coast of the Sea of Okhotsk. Swamps are numerous in hummocky tundra; *Hypnum* polygonal swamps are found in the north, and *Sphagnum-Carex* swamps in the south. The stony or sandy hillocks are mostly covered by shrubs such as dwarf birch and pine. The same scrub tundra occurs in the piedmont area, especially in the south, and in places along the Pacific coast. Mosses and lichens are usually found under the scrub vegetation. In river valleys hummocky tundra alternates with *Carex-Hypnum* swamps. Non-swampy areas are occupied by thickets of scrub birch and willows.

The sedge, cotton grass and hummocky scrub tundra serve as reindeer pasture. Some vegetables are grown in places by the local population.

2d. *Scrub tundra*

The southern subregion of scrub tundra lies mostly in western and central Siberia. The main components of this type of tundra are scrub birch (*Betula nana*, *B. exilis*) and willows (*Salix phylicifolia*, *S. glauca*, *S. lapponum*, *S. lanata*). In addition to *Hypnum* and *Carex-Hypnum* swamps, *Sphagnum* swamps occur in this region, frequently in 4- to 6-metre-thick peat deposits. In better-drained plains, xerophilous mosses as high as 3 to 5 cm develop a thin carpet, and numerous lichens, rare grasses, and dwarf birches 10 to 15 cm high grow scattered over the hummocky microrelief. Tundra mottling is not characteristic here. Surfaces with lichens and mosses occur frequently. Elongated swamps with sedge and cotton grass are common in depressions. Scrub tundra serves as winter pasture for reindeer.

2e. *Montane tundra and open vegetation of the northern mountains*

Montane tundra occupies large areas in northern Asia, not only in the 2e and 3h regions, but also at similar altitudes in other mountain regions. In the tundra belt, montane tundra is best represented in the mountains, and in the temperate belt several variants occur.

Three temperature belts for montane tundra may be distinguished: the lower belt, with temperatures higher than in the plains owing to inversion of temperature; the middle belt, where temperatures are somewhat lower than in the plains but higher than they should be under the normal drop in temperature with altitude; and the high belt, which is characterized by strong winds that blow away snow and by heavy runoff, which result in an increased dryness. Heavy snows, higher rainfall, relatively free drainage, and large areas of fine earth materials characterize the lower belt of montane tundra and provide better ecological conditions for plant growth than those in the plains. In the middle belt the vegetation is poorer than in the plains. In the upper belt physical weathering predominates, with the formation of large areas of rock outcrops and stony beds, and vegetation is very sparse. Thus, scrub tundra predominates over the lower belt of montane tundra; some islands of low open forest occur in the valleys and in well-drained watersheds. The middle belt is represented by mossy and lichenous tundra, and the upper belt resembles arctic tundra or even arctic wastes. Montane tundra is used mostly as a game reserve, and rarely as pasture.

3. Taiga forest

The great belt of temperate coniferous taiga forest occupies almost all of the plains and mountains of

Siberia and the Far East region of the U.S.S.R. Nine vegetation regions may be differentiated on the basis of ecological conditions and forest composition.

3a. *Forest-tundra*

Forest-tundra is shown on the map as a continuous separate region only in northern central Siberia, but this intermediate type also occurs widely in the northern parts of western and eastern Siberia in spots or in narrow strips between the tundra to the north and the taiga to the south; these are not shown on the map owing to the small scale.

The vegetative cover consists of open forest and treeless tundra. The forest and tundra elements are combined here generally, but for the most part are separated in accordance with edaphic factors. The upper parts of low and gently sloping hills are occupied by tundra, whereas open forest occurs on southern slopes and in valleys and ravines. The forest comprises birch, spruce and Siberian larch. There is an undergrowth of some shrubs, and the soil is partly covered by mosses, lichens and semishrubs. A hummocky microrelief is characteristic, as for tundra. There are numerous swamps in the depressions. These areas provide winter pasture for deer.

3b. *Dark coniferous and pine taiga forest*

The western Siberian taiga begins approximately at the Arctic Circle in the north and extends south as far as a line from Tyumen to Tomsk. The distribution of vegetation is conditioned by the relief, the depth of ground water, and the lithological composition of the soils. On steep relief, pine forest grows on southern slopes and spruce with fir along shaded ravines. On level relief, poor drainage, impervious clays near the surface and 500 mm of precipitation annually make the soil swampy, and a humid summer with little evaporation and high relative humidity reinforces this condition. Bogs are common in the area. The watersheds provide optimum conditions for the accumulation of peat and the development of strongly acid peat bogs. The same factors contribute to the broad distribution of dark coniferous forest, a dense, sombre, swampy spruce and fir taiga which also includes larch and pine. The most favourable places for forests are high areas along river valleys, and hills between swampy watersheds.

The change of climate from north to south divides the taiga into three latitudinal subzones: the northern taiga (sparse swampy spruce-larch forest), the middle taiga (marshy pine forest), and the southern taiga (mixed coniferous forest with swampy areas).

The sparse forests of the northern taiga have poor tree growth and little standing timber owing to low temperatures, and in the northern part resemble the woods of the southern forest-tundra. Spruce-larch forest predominates, with spruce dominant on clay soils and larch on sand. The general swampiness has led to a broad distribution of treeless peat bogs on watersheds, and to the shifting of the forest to the well-drained banks of rivers.

The area covered by the middle taiga is large. Because of the exceptional swampiness of the large level areas between rivers, the forests do not occupy them, but form strips that extend for many kilometres along rivers. Siberian pine (*Pinus sibirica*) is the dominant forest tree, but usually occurs in association with larch, spruce, fir, birch and aspen, although there are pure stands in river valleys.

The southern taiga covers an area somewhat smaller than the previous one, but forms much thicker stands; the trees are sturdier and there are no marsh plants in the undergrowth. In the north the dense coniferous forest consists of associations of fir, spruce and Siberian pine in almost equal proportions; in the south fir predominates (60 percent), with large numbers of spruce and Siberian pine (30 percent) and fewer larch trees.

Many areas of taiga have been burned over; the growths on these areas are of different ages and represent different stages of vegetative regeneration. In some thinly populated places this taiga type has survived untouched by fire.

3c. *Larch-pine taiga forest*

This type of taiga is varied and is unevenly distributed throughout the region. The northern taiga receives copious rainfall and has a moist soil. The timberline lies at about 1 300 metres' altitude, but individual larches are found at 1 600 metres. The most widespread types of the dominant Dahurian larch (*Larix dahurica*) forest are larch forest with an undergrowth of Dahurian rhododendron on steep slopes; larch forest with red bilberry on gentle slopes; larch forest with wild rosemary on the lower parts of gentle slopes; larch forest with Middendorf birch and red bilberry growing over forest burns; larch forest with continuous moss cover; bottomland larch forest with wild rose, ripple-leafed spirea, and black, red, and creeping currants (*Ribes nigrum*, *R. pubescens*, *R. procumbens*); larch forest with scrub birch (*Betula fruticosa*); and larch forest with scrub alder (*Alnus fruticosa*). Occasionally mixed with the larch are Siberian pine, fir, and Ayan spruce. Pine and fir grow in the upper part of this forest belt and in areas influenced by Lake Baikal.

3d. *Larch forest*

Larch forest occupies a large region of central Siberia which may be divided from north to south into three climatic belts of northern, middle and southern taiga. The vast taiga of central Siberia differs considerably from the corresponding taiga of the western Siberian lowland. The higher, partly mountainous relief and the large areas of rocky surfaces contribute to a good drainage. The extreme continentality and dryness of the climate result in less swampiness and in the infiltration of steppe vegetation far into the taiga. These factors have led to the predominance of a uniform Dahurian larch taiga with some Siberian pine and a few dark conifers, the growth of scrub alder as a forest undergrowth, the presence in the drier larch forests of many steppe species and even small patches of steppe with feather grass and fescue, and fewer and smaller bogs.

The northern belt of sparse larch forest lies between the southern boundary of the forest-tundra region and the Arctic Circle, and is characterized by swampiness and numerous rock outcrops. The dominant Dahurian larch occurs with some pine and spruce, but no fir. In the northern half, sparse, swampy forests that are transitional to forest-tundra predominate; in the southern half, they become drier and denser.

Middle taiga occupies the largest part of the region south of the Arctic Circle. In the moister western part Siberian larch forest predominates, and a dark coniferous forest of Siberian pine, fir and spruce is also important. In the drier eastern part the Dahurian larch is more common, as it is better adapted to permafrost; pine forest occurs on sand in association with some birch and aspen.

The southern taiga, stretching approximately from the 60th parallel, has mostly pine in the west, larch in the east, and dark coniferous taiga along high watersheds.

The northernmost patches of wooded steppe and pure meadow steppe occur in the middle of pure taiga in the Vilyui valley, in the Lena river valley, and on the Lena-Amga watershed, where dense taiga comes into contact with feather grass, and solods, Solonchaks and Solonetz occur.

3e. *Montane dark coniferous taiga forest*

This forest of spruce, pine and fir occurs widely throughout the taiga belt of Asia in the mountain systems of central and eastern Siberia. It especially characterizes the mountain ranges west of the Yenisei river, the Altai and Sayan ranges, and the Sikhote Alin and southern Sakhalin mountains. On the lower mountain slopes fir-aspen forest is dominant, fir, fir-pine or fir-spruce-pine forests predominate at higher elevations, and montane tundra occurs on summits. Steppe formations occupy the lower southern slopes of the Altai and Sayan ranges.

3f. *Montane dark coniferous taiga forest and montane larch and pine-larch forest*

These types of taiga forest occur in the upper Amur and Sea of Okhotsk areas of the Far East region of the U.S.S.R. In the southern part of the region forests occur from sea level up to 800 to 1 200 metres, and in the northern part only up to 400 to 600 metres. Ayan spruce and white-barked fir predominate throughout the south, with some larch forests in the moister valleys. In the northern part of the region larch and pine-larch forests predominate, and are replaced by montane tundra at altitudes above the tree line. Bare rocks and numerous stony cones occur on the tops of mountains. The productivity of the northern forests is poor; that of the forests to the south is better.

3g. *Montane larch and pine-larch forest*

Dahurian larch and Siberian pine are the dominant species in this region, which constitutes the main belt of the central Siberian southern taiga. Pure larch forest occurs mostly in the eastern part of the region, while pine and larch-pine forests are more typical for the western part owing to the differences in climatic conditions, and especially the depth of the permafrost. On the high watersheds, which have a cool summer and ample precipitation, there is a dark coniferous taiga of fir, Siberian pine and spruce.

3h. *Montane open larch forest and montane tundra*

Severe climatic conditions limit the variety of woody plants in this large mountainous region of eastern Siberia; the sole conifer and dominant tree species is the Dahurian larch. In the Indigirka valley it is found as far as 70°15′N. The harsh climate is also responsible for the sparse forest stands so typical of a subpolar region. The climatic conditions also impose a low altitudinal limit on the spread of forest vegetation. The timber line varies on different ranges from 50 to 1 000 metres, above which tundra invariably occurs. The density of larch forests decreases toward the north. On southern slopes forest growth is more successful; on the northern slopes vegetation is of the forest-tundra type. Montane larch forest is replaced in the lowlands by sparse swamp stands. Montane tundra is of the moss-lichen type and is found all the way up to the rocky "goletz" mountain tops.

3i. *Montane pine forest*

Montane pine forest predominates in southern Transbaikalia. Dense, pure stands of Siberian pine are of high economic value. Spruce and poplar line the bottoms of broad ravines and the banks of rivers. Birch and aspen occur on foothills and cover old burned-over areas. Siberian pine groves with an undergrowth of Dahurian rhododendrons and a cover of red bilberries or lichens are prevalent. At an elevation of a little over 2 000 metres, pine forest is replaced by subalpine thickets of dwarf stone pine and montane tundra.

4. Temperate deciduous small-leaf forest

This forest type occurs in two regions, the first representing a transition from the southern taiga of western Siberia to meadow steppe vegetation, and the second a specific Pacific vegetation region of the Kamchatka Peninsula.

4a. *Western Siberian aspen-birch forest*

A narrow transitional belt of birch and aspen forest occurs on the southern border of the western Siberian taiga. A substantial number of spruce, fir and Siberian pine trees and the development of a typical taiga grass cover show that this forest is secondary, growing on the site of burned-over taiga. Toward the extreme southern edge of the region the forest becomes primary park-like groves of European birch with a cover of light-loving meadow-forest grasses.

4b. *Pacific open birch forest and grassland*

These are rather peculiar plant associations of the Kamchatka volcanic region. Birch forest occupies large areas along the sea coasts. The western Okhotsk coast, with its comparative flatness, clay soil, and cold, moist, foggy summers, has many large bogs, not only in the lowlands, but also on watersheds. The alternation of bogs and rock birch groves characterizes this belt. Further inland, where the flat watersheds give way to hills, there is less boggy ground, and the rock birch, taller and thicker, forms pure stands over vast areas. On the mountainous east coast, the foothills are covered by pure stands of rock birch, and alder thickets occur at higher elevations. The birch thickets are park-like, with many glades. Some have a solid brushy undergrowth of mountain ash and alder, and in others the undergrowth consists of tall herbaceous plants and there is no moss cover because there is so little shade. The rock birch forests of the Kamchatka Peninsula are of great economic importance, providing hard, clear, easily worked lumber as well as pasture for cattle, and are also an excellent hunting ground. Thickets of shrubs and small trees are common throughout the area, forming a definite belt in the mountains above the tree line and often occurring in forest undergrowth at lower elevations.

The rivers and forest meadows are one of the main resources of the region, but they have not been adequately exploited. In the river valleys there are extensive meadows of tall reed grass (*Calamagrostis langsdorffii*), with patches of bog vetch (*Lathyrus palustris*) and burnet (*Sanguisorba tenuifolia*). Other riverside meadows have more diversified stands of tall grasses and herbs, including large cow parsnip (*Heracleum dulce*) (up to 5 metres high), bear's angelica (*Angelica ursina*), Kamchatka nettle (*Urtica platyphilla*), and groundsel (*Senecio palmatus*).

5. Temperate deciduous broadleaf forest

Mixed deciduous broadleaf forest is found in the plains of eastern Asia, and an even more composite mixed broadleaf-coniferous forest occurs in the mountains. This forest type occurs only in the Far East.

5a. *Temperate deciduous broadleaf forest*

This forest is very typical of the Far Eastern forest province of Asia, occupying the Zeya-Bureya upland, the lower Amur region, northern Sakhalin, the Ussuri-Khanka basin, central Japan, most of the Korean Peninsula and the Ch'in Ling and Shantung regions of China. From north to south forests vary in floristic composition but have much in common in their physiognomy and ecology. The flora not only comprises many species, but also presents some extraordinary contrasts. Its mixture of northern Siberian taiga species with southern Chinese and Indian species makes it a truly complex region in which landscapes appear subtropical in the south and Siberian in the north. The landscapes of the region are dominated by the Manchurian floristic association, consisting of a mixed broadleaf forest of southern varieties of Mongolian oak, cork oak, Manchurian walnut, maple, Korean pine and Chinese magnolia. There are many relict plants, such as cork oak, aralia and endemic *Princepia sinensis*. The Mongolian oak (*Quercus mongolica*), heterophyllous hazelnut (*Coryllus heterophylla*), elm, hornbeam and several other trees and shrubs remarkably resemble the corresponding species of Mediterranean flora. The dominant trees of the region are East Asian species of *Carpinus*, *Quercus*, *Fagus*, *Tilia*, *Ulmus*, *Acer*, *Fraxinus*, *Castanea*, *Alnus* and *Coryllus*.

Economic necessity has led to the alteration of many landscapes. They have been most affected by the cutting of timber, and by brush fires that got out of control. Fires have completely wiped out some tree species and have greatly changed the original floristic composition of many areas. The rich mixed broadleaf forest has been replaced by groves of oak, which is quickly restored by suckers that grow from the stumps. In large areas forests have been completely replaced by fields and pastures. They remain untouched only in some hilly or low-mountain areas.

5b. *Montane temperate broadleaf-coniferous forest*

This forest type occurs in northern Japan, southern Sakhalin, the Lesser Khingan mountains and the mountains of the Democratic People's Republic of Korea. It consists of Manchurian broadleaf trees, pine and fir that cover the well-watered slopes up to an elevation of almost 1 000 metres. There are intricate stands with three storeys of trees, a thick growth of underbrush and two or three tiers of grasses. The forest is dense and shady. Side by side are blue-green pines, elms with enormous light trunks, dark green firs, and walnut trees with dark grey trunks. Vines twist around their trunks and branches, almost to their tops, and epiphytes cling to them. Due to the variety and thickness of the vegetation and the presence of vines and epiphytes, this type of forest resembles those of the subtropics even though it includes no subtropical evergreens. The first storey of the forest is composed of large, widely spaced conifers: Korean pine (*Pinus koraiensis*) and fir (*Abies holophylla*). The second storey includes deciduous trees such as yellow birch (*Betula costata*), elm (*Ulmus montana*), linden (*Tilia amurensis*), narrow-leaf maple (*Acer mono*), Manchurian walnut (*Juglans mandshurica*), Amur cork tree (*Phellodendron amurense*), Mongolian oak (*Quercus mongolica*) and kalopanax (*Kalopanax ricinifolia*). The third storey comprises species such as hornbeam (*Carpinus cordata*), Manchurian linden (*Tilia mandshurica*), Manchurian maple (*Acer mandshuricum*) and cherry (*Cerasus maximowiczi*). The undergrowth consists of many kinds of shrubs, including hazelnut, wild jasmine, wild pepper, false spirea, and barberry. Amur grape (*Vitis amurensis*) is the dominant vine of the forest, but others, such as magnolia vine (*Schizandra chinensis*) and actinidias (*Actinidia arguta*, *A. kolomista*), occur frequently. Forests of this type are valuable timber reserves.

6. Subtropical and tropical forests

These types of forest cover southern China and southern Japan.

6a. *Tropical evergreen rain forest*

Tropical rain forest occurs only in southern Hainan, eastern Taiwan, and a narrow coastal strip in southern China. It constitutes the northern limit of the corresponding large forest regions of Southeast Asia. In southern and eastern Hainan lower mountain slopes are forestless and covered by shrub thickets. At a higher elevation the slopes are covered by tropical rain forest containing representatives of Malaysian, Indonesian and even Australian florae. The flora of the Taiwan tropical rain forest is more specific and contains many endemic species. Along the south coast of China the influence of Indo-Malaysian flora is more remarkable. As this type of forest is well known and has been described many times elsewhere, its floristic composition will not be detailed here. However, it should be noted that in this particular area the tropical rain forest occurs on mountain slopes and gradually changes its composition and physiognomy as the altitude increases, being replaced by other plant associations at higher elevations.

6b. *Subtropical evergreen rain forest*

This forest type, in general very similar to the previous one, occurs in vast areas of southern China, southern Japan and a small coastal strip in the Republic of Korea. It is usually found at elevations up to 800 metres, above which it is replaced by pine forest, and then by subalpine meadow. This forest includes several representatives of tropical flora, e.g. *Chamaerops excelsa* and several ferns and vines. However, there are fewer plant species than in tropical rain forest, especially with regard to epiphytes. It is dominated by numerous evergreen oaks (e.g. *Quercus gilva*, *Q. vibrayeana*, *Q. acuta* and *Q. glauca*), and also includes many deciduous oaks, Japanese cherry, maples, *Cinnamomum camphora* and other subtropical evergreen and deciduous trees. In Japan there is a very specific subtropical evergreen forest of endemic conifers which sometimes form pure stands on mountain slopes. It comprises different species of *Abies*, *Tsuga* (*T. sieboldii*), *Pinus* (*P. densiflora*, *P. thunbergii*), *Cipressus*, *Cryptomeria*, *Thuja*, *Tujopsis*, *Sciadopitis*, *Podocarpus*, *Cephalotaxus*, *Torrea* and *Taxus*. The bright undergrowth of numerous flowering *Asalia*, *Aralia*, *Magnolia*, *Gardenia*, *Paulonia* and *Vistaria* is characteristic. This type of forest contains many valuable trees which give good timber and products such as tung oil and camphor.

Bamboos, very common in this region, sometimes form pure stands as secondary growth.

6c. *Subtropical deciduous forest*

This type of monsoon forest occurs in southern China (Kwangtung), northwestern Hainan and western Taiwan. The larger part of this forest has been destroyed and replaced by cultivated fields or secondary vegetation including dense shrubs and bamboo thickets; very few undisturbed areas remain. The forest contains several tropical and subtropical tree species. *Tectona* species and several Dypterocarpaceae make it similar to the monsoon forest of Indochina. Evergreen trees usually occur in association with deciduous ones. Vines, epiphytes and ferns are not as conspicuous as in moist forest, but the total number of plant species is still great.

6d. *Subtropical xerophilous evergreen hardleaf forest*

This type of forest characterizes the drier parts of southern China, especially the Szechwan basin, part of Yunnan, Tapieh and the upper Yangtze mountain region. Evergreen oaks and camphor trees occur in association with xerophilous conifers such as *Kenninghemia* sp., *Pinus massoniana* and *P. armandii*, and some cypresses. The fen palm tree (*Trachycarpus excelsus*) reaches its northernmost limit here. The driest slopes are covered by steppe-like vegetation comprising several species of *Poa*, *Bromus*, *Dactilis*, *Festuca*, and several shrubs such as wild rose and *Philipendula* species. Pure stands of *Pinus sinensis* occur sporadically. Camelias, magnolias, thorny oaks and gleditchias are typically found in this type of forest. Bamboos are abundant everywhere as secondary growth.

6e. *Subtropical montane pine forest*

Subtropical pine forest is dominant on the dry upper slopes of the southern and eastern Himalayas. Groves also occur on the Yunnan plateau. This forest is rather open and contains little undergrowth, and grass cover is usually well developed.

7. Meadow steppe

This constitutes the transitional forest-steppe (wooded steppe) belt of Asia, and is represented by a broken chain of separate regions extending from west to east on the southern boundary of the forest zone.

7a. *Meadow steppe with oak forest*

This type of forest-steppe is typical for northern Manchuria. It is a rather specific plant formation known as Far Eastern moist forest steppe, which is of secondary origin. Mongolian oak, Manchurian walnut, Manchurian and Amurean lindens, Manchurian maple, and hornbeam are the main tree species in scattered patches of forest. The steppe vegetation includes numerous Dahurian, Mongolian and northern Chinese grass species. Most areas within this region are under cultivation.

7b. *Meadow steppe with birch forest*

This forest type is a western Siberian variant of forest-steppe. The wooded steppe of the western Siberian lowland extends to more northerly latitudes than the European steppe, and has a more continental climate and less precipitation. The landscape consists of steppe with small scattered groves of birch trees. Solods, Solonetz and Solonchaks occur in depressions in a vast area in which Chernozems predominate. Abundant ground and surface water characterize this area, which is geologically rather young, flat and poorly drained. The vegetative cover is very complex, including all the transitions from feather grass steppe to moist meadow, bogs, and open water. Forests of birch and aspen occur in small, well-moistened low areas. Halophytic meadows are also common.

8. Steppe

The broad steppe belt occupying central Asia between the forest and desert belts makes a prominent transition zone. The steppe varies from west to east and from north to south in accordance with the change of climate, and especially the degree of continentality. The floristic differences between central and eastern Asia also contribute to the variety of steppes. The vegetation of the steppe zone is characterized by uniform composition, the predominance of cereals (especially the xerophilous feather grasses and fescue grasses) over southern grasses, associations of the chief steppe xerophyte species, the marked xerophilous quality of grasses and herbs which reflects their persistent struggle to survive under conditions of insufficient precipitation and ground moisture, less turfing of the soil than elsewhere, and the complex rotation of a few plant categories.

8a. *Feather grass-fescue Kazakhstan steppe*

This steppe occupies the southernmost edge of the western Siberian lowland and the northern part of the Kazakh hill country. The monotonous vegetative cover consists largely of xerophilous narrow-leaf turf grasses, especially *Stipa capillata* and *Festuca sulcata*. *Stipa zalesskii* is common and some narrow-leaf grasses (e.g. *Stipa stenophylla*) of average xerophytic quality exist, but *Stipa lessingiana*, typical of the European steppes, is seldom found. There are numerous spring annual ephemerals. The most common legumes are *Medicago falcata* and *Astragalus macropus*, and common herbs are *Jurinea linearifolia*, *Phlomis tuberosa*, *Thymus marschallianus*, *Potentilla bifurca*, *Veronica incana*, and many *Artemisia* (*A. glauca*, *A. latifolia*, etc.). On saline and Solonetz soils halophytic plants (such as *Glycyrrhiza uralensis*, *Agropyron ramosum*, *Kochia prostrata*, and *Statice gmelinii*) are typical. At present, most of this steppe is under cultivation and does not have its natural plant cover.

8b. *Feather grass-fescue central Asian steppe*

This steppe characterizes the corresponding belts of eastern Mongolia and northeastern China. It differs floristically from the previous ones in that it comprises Mongolian and northern Chinese grass species. However, their ecological features are approximately the same. The greater part of the Manchurian plain is cultivated; natural steppe vegetation remains only in several small spots. The Manchurian steppe is very rich in plant species which lend it colour in the spring and summer: in April it is a varicoloured sea of *Campanula*, *Ranunculus*, *Potentilla*, *Cymbaria* and *Viola* species; in May it turns yellow when plants of the *Hemerocallis* species flower; and in June it turns blue with the flowers of *Delphinium* and *Centaurea* species. The western part of the steppe is drier and is used for pasture.

8c. *Fescue-tansy eastern Siberian steppe*

This type of steppe vegetation occurs widely in the Transbaikalian region. Characteristic species are Siberian tansy (*Tanacetum sibiricum*) and steppe meadow grass (*Poa botryoides*) with a dense ground cover of lichens (*Parmelia conspersa*). There is much *Festuca ovina*, but the feather grasses are less common. The driest steppes are used as poor pasture, the dominant plants being shallow sod grasses, *Diplachne squarrosa*, cinquefoil (*Potentilla bifurca*) and astragalus. White artemisia-grass steppes, widespread on saline Kastanozems, comprise sods of dominant *Artemisia frigida* which include sheep fescue (*Festuca ovina*), meadow grass (*Poa attenuata*), feather grass (*Stipa capillata*), edelweiss (*Leontopodium sibiricum*) and veronica (*Veronica incana*). This steppe is used for pasture during the spring and the first half of the summer.

8d. *Semishrub-grass Kazakhstan desert steppe*

This semidesert type of vegetation represents a gradual transition from true steppe to desert. Semishrub desert *Artemisia*, the dominant species, occurs in association with real steppe turf grasses and some halophytes. Semidesert vegetation reflects the slightest variation in environmental conditions, reacting quickly to even a minor redistribution of precipitation and salts, depending on the microrelief. As a result, the thin vegetative cover, which has a mottled composition over small areas, shows extraordinary diversity. In general, the vegetation of the desert steppe is somewhat sparse, low-growing, and of a monotonous light grey colour. The plants occupy little more than half the surface area, and thus pale patches of soil appear everywhere amid the vegetation. *Artemisia*-feather grass, *Artemisia*-fescue, tansy-feather grass, fescue-*Artemisia* and several other varieties of this steppe type can be distinguished. All are used as pasture of varying quality and are cultivated in small areas where water is available for irrigation. This type of steppe affords good grazing for sheep.

8e. *Semishrub-grass central Asian desert steppe*

This steppe is the main semidesert belt of the Mongolian region and central China. It is similar to the Kazakhstan desert steppe in general appearance and ecology, but has different plant species. *Artemisia frigida*, the main steppe-forming plant, occurs with some fescue, feather grass and *Koeleria gracilis*, and *Lasiagrostis splendens* is common in small depressions. *Caragana microphilia* forms dense low thickets amid the sparse steppe cover. This steppe type is a transition from the Transbaikalian steppe to that of the Gobi and other central Asian deserts. Although it has a rather low productivity, it is of economic importance because it constitutes the main pastureland of Mongolia.

8f. *Semisavanna*

This region occurs on the northern foothills of numerous middle Asian mountain systems bordering deserts on the south. Several vegetation zones may be differentiated according to altitude.

The lower zone is a moister version of the ephemeral desert of the loessial foothill plains up to an elevation of about 500 metres. Desert sedge (*Carex pachystylis*), meadow grass (*Poa bulbosa*), *Crocus korolkowi*, *Hyacinthus ciliatus*, various *Gagea* species, Turkistanian *Ixiolirion tataricum*, irises and tulips are the main spring flowering ephemerals. Although the number of species is not great, the vegetative cover is surprisingly dense. In the summer the landscape is desertic, and begins to flourish again in the autumn. This ephemeral desert is spring-summer grazing land that also produces much fodder. Large areas of cultivated, irrigated land occur here and there, forming valuable oases.

The semiarid zone occupies high foothills at altitudes of approximately 500 to 1 600 metres.

As there is more precipitation here than in the lower-lying desert, the vegetation acquires a semidesert character. In many places it comprises mixed couch grass. There is no solid turf and ephemerals play an important role, in contrast to the lowland semi-deserts. *Artemisia* is absent. In its place, there is a couch grass (*Agropyron pulcherrimum*), and bulbous barley (*Hordeum bulbosum*) is rather common.

The montane dry steppe zone, at approximately 1 600 to 2 000 metres, is well expressed everywhere from the Kopet Dag mountains in the west to the Dzungarian Ala Tau range in the east. Widespread in the zone is a dry feather grass-chaco grass steppe very similar to the lowland Kastanozem steppe of Kazakhstan in development of steppe sod grasses, degree of soil cover, and participation of ephemerals. It is distinguished from that of Kazakhstan by the homogeneity of the soil and plant cover and by the absence of Solonchaks and Solonetz soils.

Within the steppe and semidesert mountain zones in the southern part of the region, four valuable plants are abundant: pistachio, pomegranate, almond, and a shrub of the buckthorn family that bears edible fruits. These scattered trees and shrubs create a savanna or parkland-type landscape. The region is a zone of dependable irrigated and rainfed crops, and is of high agricultural value.

8g. *Montane steppe and montane forest-steppe*

These steppe types mainly characterize the Khangai mountains of northern Mongolia, but also occur widely in small patches in all central Asian mountain systems of the steppe and desert regions. In composition and general features they range from the more humid to drier types according to local conditions and floristic zones. Most are rather dry, featuring fescue and *Artemisia* dominants and feather grass co-dominants. They provide rather good mountain pasture and are widely utilized.

9. Desert

Large deserts are the main landscape feature of rainless central Asia, occupying lowlands, uplands, montane plateaus and high-mountain areas. Some parts of these deserts have sparse vegetation, and others are absolutely vegetationless.

9a. *Semishrub Turan desert*

This desert type occupies the Turan plain in the north of the great middle Asian desert belt. It is similar to Mongolian desert, with which it has many plant species in common. The sparse vegetation comprises mainly drought-resistant perennial semi-brushwood and semibushes of a distinct xerophytic appearance. The vegetative cover comprises certain species of the goosefoot family and some artemisias, but bare soil predominates. Despite the sparseness and rarity of the vegetative cover, several species form different associations with well-defined patterns. In basins, where Solonchaks and Solonetz develop, there is an association dominated by *Anabasis salsa*; artemisias predominate on elevated areas with a slightly saline soil; and intermediate positions are occupied by a *Salsola arbuscula*-dominated association. In the desert pastures formed by this type of vegetation, plant growth is very poor. *Artemisia terrae albae*, *A. turanica* and *A. maikara* provide fodder for sheep, especially during winter.

The northern sandy deserts of this region are very different from the adjacent clay and rocky deserts. Among them are the Big and Little Barsuki, the pre-Aral Kara Kum, the Muyun Kum, and the pre-Balkhash sands. They are characterized by scattered groves of saxaul (*Ammodendron karelini* and *A. sieversii*), and by grasses such as *Agropyron sibiricum* and *Stipa hohenackeriana*.

9b. *Semishrub central Asian desert*

This region includes the Dzungarian and Gobi deserts with clay and rocky surfaces and very few areas of shifting sands. They resemble the corresponding northern desert of middle Asia in both general physiognomy and floristic composition. Artemisia-halophyte associations predominate, with more halophytes on saline ground and more artemisias on non-saline areas. The poor sheep pasture provided by this type of desert is widely used, but produces little fodder.

9c. *Saxaul sandy desert*

This southern region of middle Asia comprises the partly stabilized sandy deserts of Kara Kum and Kyzyl Kum. Organic life exists within the narrow limits set by available moisture, which in general is utilized much more efficiently than in clay or stony deserts. When left undisturbed, the sand becomes covered with vegetation which subsists with the moisture provided by the underground condensation of water stored in the substratum. The large areas of barchan, ridge and mound sand do not have a clearly formed soil cover, and other large areas are covered by shifting sands. The characteristic desert plants are desert sedge (*Carex physoides*), *Ammodendron conollyi*, *Calligonum caput medusae*, three-awn (*Aristida pennata*), *Smirnovia turkestana*, and bush halophytes such as *Salsola subaphylla* and *S. richteri*. The most prominent plant is white saxaul (*Haloxylon persicum*), which grows as a 3- to 4-metre-high tree or as a semibrushwood.

This sandy desert is a livestock raising region. In comparison with the grazing lands of other types of desert, it offers the advantages of higher productivity, better fodder quality of grasses and bushes, less dependence on the weather, and the certainty of having fodder in the winter — the critical period for animal husbandry. The most important fodder plants are sand sedge and three-awn, followed by annual grasses and certain legumes, especially astragals.

9d. *Shifting sand desert*

The largest areas of shifting sands occur in the Takla Makan and Tsaidam deserts of central Asia, and some also occur in other types of desert, especially in middle Asia. They have mostly barchan or dune relief. Some are being stabilized by various psammophytes, but most consist of wind-blown sand and have no vegetation.

9e. *Stony and gravelly desert* (*hamada*)

This type of desert is more typical of northern Africa and the Arabian Peninsula than central Asia. However, large areas of stony surfaces occur in the Tarim, Turfan-Ka-shun, Gobi and Tsaidam deserts. These stony or gravelly surfaces are practically bare of vegetation.

9f. *Halophytic desert*

Halophytic desert occurs widely in middle and central Asia, but all its areas (except one in the Tsaidam desert) are too small to be shown separately on the small-scale map. This vegetation type occurs in small areas of almost every desert region of Asia. The region is characterized by the predominance of saline soils and Solonchaks, and hence by pure halophytic plant associations in places where the plants are able to tolerate a high soil salinity. Bare salt crusts and wet salt basins are also typical. The vegetation of the salt deserts does not occupy vast continuous areas, but grows in comparatively small scattered zones. The chief areas of development of the halophytic landscape are river terraces where brackish water lies close to the surface. Salt marshes are typical for undrained closed basins having ground water near the surface. There are few halophytic species, and they do not differ much in form and structure. There are either fleshy saltworts (succulents) or plants which exude salts, such as the grass *Aeluropus littoralis*, *Frankenia* plants, and *Tamarix* bushes. Saltworts are readily eaten year-round by camels and sheep, and hence the salt deserts are not the worst desert pastures. One of the more unusual salt desert plants is black or halophytic saxaul (*Haloxylon asphyllum*), which is common in the deserts of middle Asia on the drier saline soils.

9g. *High-mountain desert*

This large central Asian region includes the highest mountains of the Karakoram and Tibetan ranges. It has an extremely continental high desert climate of central Asian type. Under cold, dry climatic conditions, rocky, rubbly or weakly developed soil predominates on diversified bedrock and loose strata. The highest parts of the ranges with rocky outcrops and scree have only small isolated patches of sparse vegetation. The widely scattered squat plants form grazing land of low fodder capacity. Rocky desert-type vegetation predominates on mountain slopes and upper river terraces; it consists primarily of small bushes or perennial grasses. The chief landscape plant, the squat desert semibrushwood halophyte (*Eurotia ceratoides*), grows in association with crazy weed (*Oxytropis chiliophylla*) and certain mustards (*Christolea pamirica*). Such plants as meadow grass (*Poa attenuata*) and fescue (*Festuca violacea*, *F. rubra*) are of some significance in the rocky deserts. In western Tibet there are numerous mountain lakes, most of which are salty. Around them are Solonchak soils and corresponding halophytic vegetation. The flora of western Tibet is extremely poor, containing some 50 plant species, of which 10 are endemic. In southern Tibert there are nearly 500 species and the vegetation is more varied, especially in the valleys where there is extensive agriculture. Eastern Tibet has more varied landscapes; some steppe and even forest vegetation appears on the cold stony desert where conditions are favourable. These areas have still not been adequately studied.

10. Subalpine and alpine meadows

These meadow types occur at high elevations in all the central Asian mountain systems. The region forms a continuous belt through the Tien Shan, Kunlun, Karakoram, Nan Shan and eastern Tibetan ranges. These types of vegetation also occur in small areas in other mountain ranges at corresponding altitudes.

The subalpine zone is a complex of subalpine meadows, coniferous forests, juniper or rhododendron groves, steppes, and rock outcrops and scree. In some mountain ranges it begins at 1 000 metres, and in others at 1 500 or 2 000 metres. Subalpine meadow has a comparatively short, thick grass stand and a complete turf cover. Its many species have rich, succulent foliage and large, brilliant flowers which blossom simultaneously. With their capacity for high fodder production, vast areas of subalpine meadow provide excellent summer pasture.

The alpine zone begins at the upper timber and brushwood line and extends to the very tops of the mountains, sometimes crossing the snow line. In places where there is sufficient precipitation and the relief facilitates its retention, alpine meadow develops. In places where there is less precipitation and the upper parts of thick scree are without water, the meadow gives way to the xerophytic vegetation of high-elevation steppe, or steppe grasses are introduced into the floristic composition of the meadow. A typical moist alpine formation comprises Cobresia meadow distinguished by uniformity, poor composition, and limited cover. It contains a few of the hardy moist alpine species, such as sedge or edelweiss. Drier alpine meadow contains lower-growing vegetation with a thick grassy cover, bright colour, and large flowers. The absence of annuals, the abundance of rosette species, the ability to reproduce vegetatively, and the exceptional frost resistance of the plants are typical features of this type of meadow, which includes white and varicoloured starworts, yellow crowfoot, blue gentians, rose asters, and pale yellow alpine poppies. A few pillow-like semishrubs occur on rocky slopes. Alpine meadow provides excellent summer grazing; however, the wasteful, careless nomadic economy practised in the past has greatly reduced its quality.

GEOTECTONICS

The main features of Asian surface relief and the geomorphological differences between regions are closely related to the continent's geological structure and history. North and Central Asia comprises several large blocks having similar tectonic structure and the same main relief features. The chief tectonic regions, shown on a small-scale map (Figure 3), are listed below.

1. Platforms
   - 1a. Basement outcrops
   - 1b. Regions with thin sedimentary cover, or partly without cover
   - 1c. Regions with thick sedimentary cover
   - 1d. Regions of recent subsidence
2. Marginal depressions
   - 2a. Continental marginal depressions
   - 2b. Oceanic marginal depressions
3. Southeastern China block
   - 3a. Anticlinoria developed from anticlines
   - 3b. Synclinoria developed from synclines
4. Baikal folding and Precambrian formations in Caledonian folded massifs
5. Caledonian folding
   - 5a. Caledonian folding and zones of early consolidation in region of Hercynian folding
   - 5b. Depressions with middle and upper Paleozoic sediments overlying Caledonian basement
6. Hercynian folding
   - 6a. Geoanticlinal zones with surface or shallow beds of Hercynian folded complex of Precambrian rocks
   - 6b. Gotland Ordovician geosynclinal zones
   - 6c. Gotland Devonian geosynclinal zones
   - 6d. Carbono-Permian geosynclinal zones
   - 6e. Regions with relatively shallow Paleozoic basement strata in Epihercynian platforms
   - 6f. Regions with deep Paleozoic basement strata in Epihercynian platforms
7. Mesozoic folding
   - 7a. Geoanticlinal zones with surface or shallow Precambrian beds
   - 7b. Central folded massifs
   - 7c. Geosynclinal zones
8. Cenozoic folding
   - 8a. Geoanticlinal zones with surface or shallow Precambrian beds
   - 8b. Geosynclinal zones of the Pacific belt and southern Asian mountain regions
   - 8c. Central massifs in geoanticlinal zones of Cenozoic folding
   - 8d. Subsided central massifs and recent depressions in geosynclinal zones of Cenozoic folding

The Precambrian crystalline platforms and shields that have served as the main nuclei for the gradual growth of the continent were localized by geological surveys in Siberia, China and the Russian plain. The ancient Russian, Siberian and Chinese platforms were separated by a broad belt of Paleozoic marine basins which were uplifted during the Caledonian and Hercynian orogenies. Paleozoic folded structures comprise the greater part of high central Asia.

The Russian platform, which did not play such an important role in the formation of northern Asia, served as a western mainland to the Paleozoic seas of the region. It is represented only in the basement formations of the Caspian syncline.

The limits of the Siberian platform correspond almost exactly to those of the central Siberian plateau.

The western portion of the platform is occupied by the Tunguska syncline, which has many upper Paleozoic coal-bearing deposits and andesitic sills. The sills occur throughout the platform.

The ancient Archean crystalline basement is exposed in two shields: the Anabar in the north and the Aldan in the southeast. From the south and southwest the Aldan shield is joined by the regions of Precambrian and Baikal folding. Granites, gneisses and crystalline schists occur in this area. The Anabar shield is separated from the Aldan shield by the sediment-filled Vilyui syncline.

The Chinese platform underwent subsidence several times during the Paleozoic and Mesozoic. Only portions of it outcrop in contemporary relief. One portion, a crystalline massif strongly dissected by faults, forms the Korean and Shantung peninsulas. Other parts of the ancient platform outcrop as plateaus that did not undergo Paleozoic folding and are overlain by horizontal beds of sedimentary rocks, e.g. the Ordos plateau, and the broad Tarim basin which is enclosed by the folded Tien Shan and Kunlun mountain ranges.

With the exception of the Siberian and Chinese platforms, North and Central Asia was occupied by geosynclines at the beginning of the Paleozoic. Geosynclines occur in unstable thin areas of the earth's crust. They are areas of subsidence in which great sedimentary thicknesses, mostly of marine origin, accumulate. The sedimentary deposits are subsequently deformed by orogenic forces into folded mountain chains, during which time metamorphism takes place. The folding is usually accompanied by upheaval and intensive volcanic activity, and especially by underground magmatic intrusions.

During the geologic history of North and Central Asia there were periods when folding processes were especially strong and resulted in the formation of large folded massifs. Such orogenesis began in the Precambrian (Baikal folding) and continued in the Paleozoic (Caledonian and Hercynian orogenies), Mesozoic and Cenozoic eras.

The region of the most ancient (Baikal) folding covers large areas of Prebaikalia, Transbaikalia, and the eastern Sayan and Yenisei ranges. It is composed of ancient, intensely deformed schists and gneisses, and of large granite blocks. Subsequent tectonic movements contributed greatly to the formation of the region's present surface features.

The Caledonian lower Paleozoic orogeny took place at the end of the Silurian or the beginning of the Devonian, forming the folded structures of the Severnaya Zemlya Islands, northern Taimyr, the western Sayans, the Kuznetsk Alatau, the Salair range, eastern parts of the Altai mountain system, and parts of the Kazakh upland. Here, where lower Paleozoic rocks have been compressed into folds and metamorphosed, the Precambrian basement (including some Archean rocks) outcrops often.

The Hercynian (upper Paleozoic) orogeny, which began at the end of the Carboniferous and continued through the Permian, affected an even larger area between the Russian, Siberian and Chinese platforms. This area covers almost all of central Asia in a wide arc running from the Byrranga ranges of Taimyr down through the Urals, and then through the Kazakh upland, the Altai system, the Dzungarian Ala Tau, the Tien Shan system, the Kunlun range, the Tibetan ranges and the Ch'in Ling range. Parts of the western Siberian lowland, the Turgai tableland and the Turan plain were also affected by folding. Considerable subsidence occurred later, and the Hercynian folds were buried beneath a thick cover of friable Meso-Cenozoic deposits which were folded during different periods. The Urals, the Altai system, the Kazakh upland, the Tien Shan system, the Sayan ranges, and the folded structures of central Asia have outcrops of folded basement rocks. In contrast to the western lowlands, the folded Hercynian structures of central Asia underwent strong upheavals during later periods, and at present appear as high plateaus and mountains. Southeastern Transbaikalia is the easternmost region of Hercynian folding.

Thus, at the beginning of the Mesozoic the largest part of the continent already represented a solid platform with a heterogeneous folded basement formed around the Siberian and Chinese shields. Geosynclinal conditions continued to exist only in the eastern and southern parts of the continent. However, during the Mesozoic the process of sedimentation in these geosynclines was interrupted by orogenesis. Large, mostly northeast-trending Mesozoic folded structures characterize eastern Asia. These granite-intruded structures occur in most of eastern Siberia, eastern China, and Japan. The Mesozoic folding, which took place from the Triassic to the Cretaceous, played a very important role in the formation of eastern Asia, and is most evident in southeastern China. The region of Mesozoic folding is separated from the Siberian platform by the large pre-Verkhoyansk marginal depression. The region is characterized by the central massifs in which folded Paleozoic and even Precambrian beds occur under the plain beds of Mesozoic rocks. The largest of these is the central Kolyma massif.

Both the Paleozoic and Mesozoic folded mountain systems underwent a continuous denudation until a stage of complete planation was reached. The wide occurrence of levelled surfaces and plateaus in the regions of folded structures is evidence of these processes. In many places the desert climate and the paucity of rivers and streams have contributed to the preservation of these peneplains, which have been only partly dissected by recent erosion.

The planated surfaces of the ancient folded structures of central Asia were affected by tectonic movements, faulting and differential block movements during the Cenozoic. This upheaval produced the high mountains of the Mongolian Altai, the eastern part of the Tien Shan system, and the Kunlun ranges, which alternate with the older montane plateaus. In eastern Asia the region of levelled Mesozoic structures is generally not so uplifted, and is strongly dissected by numerous breaks and faults, and by young river erosion. There is an alternation of lowlands, hilly uplands and mountains of moderate height.

The southern and Pacific Ocean tectonic belts, sites of the last and strongest Cenozoic folding and the most recent (Quaternary) vertical upheavals, border North and Central Asia on the south and east. The Cenozoic folding took place during the Paleogene and Neogene, and in some places did not finish until recent times. The Kopet Dag, Pamir, Karakoram and Himalayan ranges are the largest in the southern (west-east) belt of Cenozoic folding, and are separated from the platforms to the north by marginal depressions. The Koryak ranges, the Kamchatka Peninsula, the Kuril Islands, the coast of the Sea of Okhotsk, Sakhalin Island, eastern Sikhote Alin, Japan and Taiwan belong to the Pacific Ocean belt of Cenozoic folding.

The presence of high mountain ranges and deep depressions, frequent earthquakes, and continuing volcanism or traces of recent volcanic activity indicate that the southern region affected by the Alpine orogeny still has all the characteristics of a geosynclinal system. This is especially true for the Pacific Ocean belt, where the process of orogenesis continues.

Thus, North and Central Asia comprises several blocks clearly distinguishable in its geological structure: the Siberian and Chinese platforms; the Paleozoic folded belt separating the ancient platforms; the Mesozoic folded belt of eastern Asia, and the southern and Pacific Ocean folded belts which originated during the Cenozoic. These structures are clearly visible in contemporary relief.

GEOMORPHOLOGY

The four main groups of morphostructural regions distinguished in the description of the tectonics of North and Central Asia also represent definite regions characterized by a distinct landscape development. While the geological history of the different regions contributed to the formation of present landforms, most of the present relief and general contours of the continent were formed during the Quaternary, when violent upheavals were accompanied by differential oscillating and block movements in the peripheral sea coast belt. Subsidence contributed to the geologically recent separation of Japan from the continent.

Giant mountain systems, large highlands and considerably elevated plateaus predominate in the relief of North and Central Asia. The lowlands, although large themselves, occupy much smaller areas. They were mostly formed by alluvial, diluvial and glacial deposits produced by the denudation of the adjoining mountain systems. The largest lowlands are the western Siberian lowland, the Turan plain, the northern Siberian lowland, the north China and Yangtze plains, and the Manchurian plain, all of which are of alluvial origin.

On the small-scale geomorphological map (Figure 4), 26 geomorphological regions are grouped under three main landscape regions and subdivided into the following 123 smaller but still broad landscape units:

1. Lowlands
    - 1.1 Turan plain
        - 1.11 Caspian recent marine alluvial lowland
        - 1.12 Ust Urt plateau
        - 1.13 Ridge escarpments with tectonic faults
        - 1.14 Stratified tablelands with degrading surfaces
        - 1.15 Old marine alluvial lowland with degrading surface
        - 1.16 Stratified dissected tablelands with degrading surfaces
    - 1.2 Western Siberian lowland
        - 1.21 Pyasina-Khatanga depression
        - 1.22 Recent coastal marine alluvial plain
        - 1.23 Flat to slightly undulating glacial plain
        - 1.24 Fluvioglacial flat to rolling plain dissected by erosion
        - 1.25 Isolated stratified gullied plains
    - 1.3 Northern Siberian lowland
        - 1.31 Yana alluvial plain
        - 1.32 Indigirka alluvial plain
        - 1.33 Kolyma alluvial plain
    - 1.4 Penzhina-Anadyr lowland
    - 1.5 Ussuri-Khanka lowland
    - 1.6 Manchurian plain
        - 1.61 Northern Manchurian plain
        - 1.62 Southern Manchurian plain

- 1.7 North China and Yangtze plains
  - 1.71 North China plain
  - 1.72 Lower Yangtze plain

2. Uplands and plateaus
- 2.1 Turgai plateau
- 2.2 Kazakh upland
  - 2.21 Hilly plain of central Kazakhstan
  - 2.22 Teniz Mulda depression
  - 2.23 Chu Mulda depression
  - 2.24 Depression of Ili-Balkhash sinclynorium
- 2.3 Central Siberian montane plateau
  - 2.31 Northern Siberian undulating coastal plain
  - 2.32 Anabar massif
  - 2.33 Anabar shield
  - 2.34 Putorana massif
  - 2.35 Yenisei ranges
  - 2 36 Vilyui-Lena basin
  - 2.37 Tunguska plateau
  - 2.38 Angara plateau
  - 2.39 Lena-Aldan plateau
  - 2.39a Angara hilly upland
  - 2.39b Pre-Sayan foothills
  - 2.39c Aldan shield
- 2.4 Central Asian plateau
  - 2.41 Eastern Altai hilly sloping plain
  - 2.42 Dzungarian depression
  - 2.43 Turfan depression
  - 2.43a Tarim depression
  - 2.44 Takla Makan dune plain
  - 2.45 Transbaikalian hilly plain
  - 2.46 Barga plain
  - 2.47 Gobi plateau
  - 2.48 Ala Shan massif
  - 2.49 Ordos massif
  - 2.49a Eastern Greater Khingan foothills
  - 2.49b Ch'in Ling hilly upland
  - 2.49c Tapieh mountains
  - 2.49d Loess plateau
- 2.5 Szechwan basin plateau

3. Mountains
- 3.1 Urals
  - 3.11 Ural range
  - 3.12 Stratified graded slopes of Uıal-Tobol hilly upland
  - 3.13 Trans-Volga tableland
- 3.2 Taimyr region
  - 3.21 Byrranga range
  - 3.22 Northern Taimyr hilly coastal plain
  - 3.23 Severnaya Zemlya Islands
- 3.3 Eastern Siberian mountain system
  - 3.31 New Siberian Islands
  - 3.32 Verkhoyansk range
  - 3.33 Yana plateau
  - 3.34 Oimyakon plateau
  - 3.35 Cherski range
  - 3.36 Yudom-Maya plateau
  - 3.37 Yukagirsk plateau
  - 3.38 Kolyma range
  - 3.39 Anadyr-Chukotski ranges
  - 3.39a Anadyr plateau
  - 3.39b Chukot range
  - 3.39c Chaun-Chukchi coastal plain
  - 3.39d Dzhugdzhur-Okhotsk ranges
  - 3.39e Okhotsk plateau
- 3.4 Koryak-Kamchatka-Kurilian volcanic chain
  - 3.41 Koryak mountains
  - 3.42 Central and eastern Kamchatka ranges
  - 3.43 Eastern Kamchatka hilly plain
  - 3.44 Central Kamchatka depression
  - 3.45 Western Kamchatka coastal plain
  - 3.46 Kuril Islands
- 3.5 Altai-Sayan region
  - 3.51 Pre-Altai piedmont plateau
  - 3.52 Pre-Altai hilly sloping plain
  - 3.53 Altai ranges
  - 3.54 Altai-Sayan ranges
  - 3.55 Khangai-Khentei ranges
  - 3.56 Tuva basin
- 3.6 Baikal mountain country
  - 3.61 Eastern Sayan ranges
  - 3.62 Prebaikalian montane plateau
  - 3.63 Stanovoy montane plateau (Transbaikalia)
  - 3.64 Stanovoy range
  - 3.65 Aldan montane plateau
- 3.7 Eastern Asian mountain system
  - 3.71 Greater Khingan ranges
  - 3.72 Upper Zeya hilly plain
  - 3.73 Turana-Bureinski ranges
  - 3.74 Zeya-Bureya hilly plateau
  - 3.75 Eastern Greater Khingan foothills
  - 3.76 Lower Amur hilly plain
  - 3.77 Sikhote Alin ranges
  - 3.78 Northern Sakhalin hilly plain
  - 3.79 Southern Sakhalin ranges
  - 3.79a Japanese ranges
  - 3.79b Korean ranges
  - 3.79c Shantung ranges
- 3.8 Tien Shan region
  - 3.81 Tien Shan ranges
  - 3.82 Northern Tien Shan piedmont plateau
  - 3.83 Western Tien Shan piedmont plateau

- 3.9 Kopet Dag region
  - 3.91 Kopet Dag range
  - 3.92 Northern Kopet Dag piedmont plateau
- 3.10 Pamir-Kunlun region
  - 3.101 Gissar piedmont plateau
  - 3.102 Badakhshan-Gissar ranges
  - 3.103 Pamir massif
  - 3.104 Karakoram range
  - 3.105 Kunlun range
- 3.11 Tibetan region
  - 3.111 Ch'iang-t'ang massif
  - 3.112 Tibetan montane plateau
- 3.12 Nan Shan region
  - 3.121 Nan Shan ranges
  - 3.122 Tsaidam plateau
  - 3.123 Ch'in Ling range
- 3.13 Himalayan region
  - 3.131 Southern Himalayas
  - 3.132 Eastern Himalayas
  - 3.133 Southeastern Himalayas
- 3.14 Southern China mountain system
  - 3.141 Southern China hilly plain
  - 3.142 Bohea ranges
  - 3.143 Nan Ling ranges
  - 3.144 Yunnan plateau
  - 3.145 Southern Nan Ling mountains
  - 3.146 Hainan Island
  - 3.147 Western Taiwan hilly sloping plain
  - 3.148 Chungyang range

As the geomorphological regions in general correspond to the broad soil regions described in Chapter 5, they will not be discussed in detail here; hence only the most important geomorphological features of the subcontinent are outlined below.

1.1 Turan plain

The heterogeneous relief of the Turan plain is due to the structural composition of the region. The western part of the plain forms the southeastern outskirts of the Russian platform, which has been a stable land mass since the Precambrian; the eastern part emerged during the Hercynian orogeny. Depressions with below-sea-level elevations occur side by side with elevated tablelands such as the Ust Urt plateau. The low plains frequently contain remnants of denuded mountains. Mesozoic, Tertiary and Quaternary rocks are widespread. Considerably weathered desert landforms characterize the region. In general, the plain is a closed, undrained basin with several large rivers that bring abundant water from the mountains to the Aral Sea.

The northwestern part of the region is occupied by the Caspian lowland, which was formed by the post-Tertiary deposits of clay and sand laid down by the Caspian transgressions. There are about seven terraces which are characterized by deposits of varying ages and composition. The surface of the Caspian Sea lies at about 30 metres below sea level, but in places the lowland drops considerably below this level (up to -140 m in the Batyr depression).

The Ust Urt plateau is an undulating karst tableland lying between the Caspian and Aral seas. In the raised central part the elevation is no more than 230 metres, but in the southwestern corner it reaches 360 metres. It is bounded on all sides by cliffs or escarpments. It is formed of horizontal upper Miocene limestone beds which alternate with saliferous marl and clay.

The eastern part of the region consists of rolling to undulating stratified tablelands with degrading surfaces. Old alluvial marine and river plains occur here and there, alternating with remnants of hills and mountain ranges. The shifting sand dunes so characteristic of this rolling country have been formed in windblown old alluvium.

1.2 Western Siberian lowland

In contrast to the Turan plain, this lowland — the largest in Asia — is homogeneous and of very low elevation; only in a few places along its edges do altitudes reach 200 metres. It is unified by the Ob river system, through which it is drained into the Arctic Ocean. It is formed almost entirely by weakly cemented Tertiary and Quaternary deposits. The eye detects little change in relief for vast distances; there are few hills or gullies along the river courses, and only low ridges and lakes interrupt the flatness of the landscape.

The main morphological features of the lowland were established when it was covered by a shallow sea during the Paleozoic and Mesozoic. All depressions were filled with marine deposits, and when the sea at last regressed, it left a gently northward-sloping plain. In the Paleocene the plain was again covered by the sea, and marine deposits from this period at present outcrop along its western and southern edges. At the end of the Paleocene the sea slowly regressed from the lowland as a result of gradual vertical upheaval of the earth's crust, and at the beginning of the Miocene a continental regime was finally established. During the Quaternary glaciation the Siberian ice sheet extended as far south as approximately 61°N. The ice sheet was not as thick as in Europe owing to the continental climate and low humidity. It moved little and thawed slowly, and consequently had little influence on its bed and left no massive boulders or thick moraines. Quaternary deposits consist of large quantities of sand laid down by running water or on lake beaches, and of moraine mixed with friable debris from Mesozoic and Paleocene strata. In general, the lowland's present structure and basic relief forms were created by lateral river erosion; huge masses of alluvia were deposited everywhere.

1.3 Northern Siberian lowland

This region consists of the broad valleys of the Yana, Indigirka and Kolyma rivers, which are separated by hilly terrain. The valley bottoms are flat, or have a gentle northward slope. This lowland is a result of combined marine and fluvial deposition. Several marine transgressions helped build it up, but the present surface was essentially formed by alluvia deposited by the big rivers and their numerous tributaries.

1.4 Penzhina-Anadyr lowland

This lowland separates the eastern Siberian ranges from the Koryak-Kamchatka volcanic ranges. It consists of the lowlands of the Anadyr valley on the north and of the Penzhina and Parapolski valleys on the south, all of which are of alluvial origin. The Penzhina-Anadyr depression is a region of subsidence between the Okhotsk-Chaun arc, the Koryak range, and the Chukchi block. Intermittent effusions of extrusives filled in great areas of the depression, as it was an area of volcanism. It was inundated by the sea until relatively recent times. The flatness of this lowland is broken by scattered small ranges.

1.5 Ussuri-Khanka lowland

This plain is a depressed, dislocated region with mountains on the west and the east, and has an average altitude of 30 metres. Unconsolidated Quaternary deposits cover the lower slopes of the adjoining mountain spurs and a few isolated hills which are composed of Paleozoic rocks, granites and andesitic basalts. The tectonic depression continues into the lower Amur plain on the north, with which in ancient times it formed a strait between the mainland and the island that is now the Sikhote Alin range. It was uplifted to its present elevation during the Quaternary.

1.6 Manchurian plain

This large lowland includes both the southern and northern Manchurian plains. It is enclosed by mountains on the west, north and east, and is open to the Yellow Sea on the south. The plains of northern and southern Manchuria are separated by a low hill range with altitudes that do not surpass 330 metres.

The northern plain is strongly eroded, has numerous residual hills composed of gneisses, granites, quartzites and basalts, and has undergone subsidence. At the beginning of the Pleistocene it was occupied by large lakes which later disappeared, and the exposed Pleistocene surface subsequently underwent erosion.

The periphery of the plain is hilly and consists of foothills dissected by erosion. The central part comprises saliferous marine deposits.

1.7 North China and Yangtze plains

These two plains are separated by the Tapieh mountains and joined by the Great Canal.

The north China plain was formed by the Huang Ho (Yellow) river and lies in the region of subsidence of the Chinese platform. It is a delta of the Huang Ho filled by a thickness of alluvium several hundred metres thick. Aeolian loess deposits and sand dunes are irregularly distributed throughout it. Numerous chloridic and suplhatic Solonchaks occur in depressions. Sands, Solonchaks and swamps occupy a large portion of otherwise cultivated land.

The lower Yangtze plain is also a deltaic region composed of thick alluvium. It is characterized by a dense network of artificial canals used for transportation and irrigation, and is completely occupied by paddy fields.

2.1 Turgai plateau

The Turgai plateau, which separates the western Siberian and Turan lowlands, lies between the Mugodzhar mountains to the west and the Ulu Tau mountains to the east. It slopes gently southward toward the Aral Sea. In its centre is a low, north-south-trending tectonic depression in which there are numerous lakes. The plateau rises to the west and east of the central depression, and the relief becomes more diversified and is enriched by hills.

Salt lakes and Solonchaks are numerous owing to the high salt content of horizontal Oligocene marine and Miocene continental deposits. The susceptibility to erosion of those loose, poorly consolidated deposits, their high salinity and gypsum content, and the height of the ancient, unbroken Tertiary plateau have contributed to the intensity of surface erosion.

At present it has a well-defined landscape of mesas with almost flat tops and steep, gullied sides.

2.2 Kazakh upland

The relief of this upland is intermediate between mountainous and hilly, or comprises separate, gently sloping hills formed by Paleozoic rocks. Among these hillocks are comparatively high, scattered individual folded massifs formed of the same rocks. In the central part of the region low mountains reach elevations up to 1 500 metres. From the high central zone the land slopes gently toward the north, west and south. The region, subjected to folding during the Hercynian orogeny, has a very complex geological structure. In depressions there are horizontal Tertiary marine deposits. The Cenozoic upheavals produced faulting, upthrusting, overthrusting, and often great dislocations along former faults. At the beginning of the Quaternary the relief in general corresponded to that of the present, except that it was more sharply defined. Subsequently, the ranges were strongly eroded and detritus was deposited in depressions. The mounded landforms are the result of a very long denudation process. Near its outer edges, the mounded country of central Kazakhstan becomes a rolling plain with scattered hills.

2.3 Central Siberian montane plateau

This vast region, lying mainly between the Yenisei and Lena rivers and bordered by Transbaikalia on the south, almost completely corresponds to the ancient Siberian platform. The folded foundation of the plateau is formed by Precambrian rocks which outcrop to form the crystalline Anabar and Aldan shields. In other places it is covered by horizontal or slightly dissected Paleozoic or Mesozoic rocks. It has many faults resulting from prolonged upheavals, and a broad development of upper Paleozoic basic igneous rocks (basaltic trap). Although on the whole it represents a horizontal tableland, the character of its relief is different. This was formed by Quaternary glaciation in the higher areas, and especially by a dense river network which separates the peneplain into isolated mesas and elongated range-like elevations. The plateau's present relief is being developed by intensive frost weathering under severe dry continental climatic conditions, and by the erosive action of the river network.

2.4 Central Asian plateau

Although it coincides in general with the main block of the Chinese platform, the central Asian plateau is very diversified, consisting of 14 separate landscape units with different geological history and relief. In its western and central portions it is a closed basin. Its surface underwent a long cycle of continental development. Mesozoic and Cenozoic seas covered only some areas on its edges. Continental deposits are represented widely in a great thickness of sandstones, saliferous clay rocks, conglomerates and marls. Igneous rocks also abound; granites, syenites and porphyries predominate, and basaltic sheets occur frequently. The tectonic movements of different periods (especially those of the Mesozoic and Cenozoic foldings) contributed to the present geomorphology. During the early Tertiary nearly the whole region was dry land. But it was not as desertic as it is at present; numerous lakes and rivers existed even in the Neogene. Depressions in the plateau contain alluvial and lake clays, marls, sands and gravel. During the Quaternary the region became drier, although meltwaters from mountain glaciers still fed large lakes in western and central Sinkiang Uighur, the Gobi depression, western Mongolia, the Ordos region and the Barga plain. Renewed upheavals which raised mountains and isolated the region from moist climatic influences increased the dryness of the area, and rocky and sandy deserts began to predominate. The large areas of the plateau occupied by peneplains, the usual forms of relief in the Mongolian uplands and other regions, were formed by prolonged denudation. Weathering under a dry continental climate has led to the destruction of entire massifs and the aeolian transportation of huge masses of sand and silt from intermontane depressions and the closed central Asian basin into peripheral regions. These processes have greatly contributed to the formation of the plateau's present relief. The traces of past water erosion are also clearly visible in the relief of the deserts. Abandoned dry river valleys have large areas of alluvial deposits which in places have been subject to wind erosion. In the deserts Takyric Solonchaks characteristically occur in closed depressions and dry river beds. Various types of sand deposits also occur on the desert plateau. The largest areas of sand dunes occur in the southern and middle parts of the plateau; originally brought by ancient rivers, the sands were subsequently reworked by the wind. Loess covers a large eastern portion of the plateau characterized by gullied canyon-like relief.

2.5 Szechwan basin plateau

This isolated plateau surrounded by mountain ranges corresponds to a block of the Chinese platform which was separated from the main platform body during Hercynian-Mesozoic times. Continuous subsidence of the basin led to the accumulation of a great thickness of red sandstones and clays and purple shales developed from detritus from the surrounding mountains. Subsequent erosion by the river network transformed the flat bottom of this large depression into a disorderly complex of flat-topped hills. In the northeastern part of the plateau is the flat Chengtu plain. The central part is occupied by the low Fan Shan upland. On the east, gently sloping broad folds in the relief form a system of low parallel ranges.

3. Mountains

The mountain regions of North and Central Asia are so large and numerous and of such varied geological history and age, and yet so similar in their landforms, that they will not be described here. They will be dealt with in more detail when the continent's soil regions are discussed in Chapter 5.

LITHOLOGY

The surface lithology of North and Central Asia varies greatly. Countless rock types could be described here, including, possibly, every kind of rock recognized in petrography. This is especially true for the mountain regions of eastern Asia, where there are rocks of all geological ages formed by all kinds of rock formation processes. On the generalized small-scale map (Figure 5) they are shown by broad types predominating in specific areas. This map of course presents only a very rough outline of the main rock formations of the different regions. If, for example, consolidated carbonate sediments are shown in some region (e.g. in Tibet), it does not mean that they are the only rocks of the region, but rather that they predominate in the area, although quite a variety of different sedimentary rocks could be found there together with small massifs of intrusives or effusives.

Also, most of the river valleys and intermontane valleys that filled up with alluvial, diluvial and colluvial materials have not been shown on the map because of the scale. Only the largest valleys are shown schematically.

As it is impossible to show on such a small-scale map all the continent's varieties of surface lithology, the following broad lithological types are recognized:

Unconsolidated sedimentary materials

Su1 Tertiary and Pleistocene saliferous marine sediments, mainly unconsolidated (with the exception of Pontic porous limestone)
Su2 Recent fluvial and coastal sediments
Su3 Subrecent and recent fluvial and lacustrine sediments
Su4 Recent deltaic alluvial sediments
Su5 Glacial moraine deposits
Su6 Fluvioglacial sediments (sand, loam, clay)
Su7 Postglacial fluvial loess-like loams
Su8 Loess
Su9 Shifting sands (originally fluvial, then aeolian)
Su10 Disintegrated rock deposits (hamadas)

Consolidated sedimentary rocks

Sc1 Consolidated clastic sediments (sandstone, siltstone, shale, conglomerate)
Sc2 Consolidated carbonate sediments (limestone, dolomite, marl)
Sc3 Cretaceous to Tertiary purple clay shale and sandstone

Metamorphic rocks

M1 Metamorphic rocks (gneiss, schist, phyllite, quartzite, slate)
M2 Granitized and migmatized basement complex (granite, gneiss, migmatite)

Intrusive rocks

I1 Acid intrusive rocks (granite, diorite, quartz porphyry, syenite, gneiss)
I2 Basic intrusive rocks (dolerite, gabbro, peridotite, serpentinite, pyroxenite, norite)

Effusive rocks

E1 Acid effusive rocks (rhyolite, quartzite, porphyry, dacite, trachyte)
E2 Basic effusive rocks (basalt, diabase, dolerite, andesite)
E3 Recent volcanic tuff and ash

Su1 The Tertiary and Pleistocene saliferous marine sediments which characterize the Caspian lowland are represented by salt-bearing and gypsum-bearing clays, sands, gravel and loams left by numerous Caspian transgressions.

Su2 Recent fluvial and coastal sediments characterize the north coast of Asia. They consist of a mixture of alluvial, diluvial and marine sediments. These materials are represented by clays, silts and sands interbedded with gravel; in places they are saliferous and gypsiferous.

*Su*3 Subrecent and recent fluvial and lacustrine sediments occur along all the continent's river valleys, in places building up rather large alluvial lowlands. They vary in texture and mineralogy and usually consist of several layers. Sands, silts, loams and clays are intercalated with gravel beds everywhere. In desert and semiarid zones these deposits are often saliferous, especially in middle and central Asia. They occur in areas much larger than those shown on the map, for they cover numerous river and intermontane valleys throughout the continent. Large patches also occur widely in the central Asian plateau, the Turgai tableland and parts of Kazakhstan which are otherwise desertic and have no rivers at present. There are many old river flats — remnants of times when rainfall was higher. Salt lakes occur frequently among these flats.

*Su*4 Recent deltaic alluvial sediments occur in the delta areas of all large Asian rivers. The largest such area, the north China and Yangtze plains, comprises the combined deltas of the Huang Ho and Yangtze rivers. The deltaic alluvium of these plains is rather peculiar, as it resembles very much the loess of the adjoining Loess plateau. Indeed, the admixture of loess material is very high in the deltaic alluvium of the Huang Ho. Salt marshes occur along the sea coast and saline soils are widespread in the delta.

*Su*5 Glacial moraine deposits cover the northern part of the western Siberian lowland. As usual, they consist of coarse materials and bear boulders. The usual assortment of end moraines, kames and sand flats is much in evidence.

*Su*6 Fluvioglacial sediments occur south of the above morainic sheet. They are represented by large sand fields alternating with loamy areas.

*Su*7 Postglacial fluvial loess-like loams occupy very large areas in the southern part of the western Siberian lowland and in the Vilyui-Lena basin. They are mostly calcareous and resemble loess in all respects, but are more clayey and never as deep and uniform. Their origin is still as doubtful as that of the loess, but they bear clearer marks of fluvial origin.

*Su*8 Loess covers large areas in middle Asia and eastern China. The Loess plateau of China is a classical example of a region with a very thick uniform surface cover of pure loess. Thin sheets of it also cover the slopes of adjoining mountains, and patches are widespread in the central Asian plateau and Kazakhstan. It is generally accepted that loess is a windborne deposit. However, in middle Asia and China the loess deposits appear to be too stratified and intercalated with salts and gypsum to be only of aeolian origin.

*Su*9 Shifting sands occur throughout the desert belt of central Asia from the Caspian Sea in the west to the Ordos plateau in the east. Usually, they occupy large areas in the lowest parts of the plateaus or lowlands near depressions. They are partly stabilized, and dune relief is characteristic. The largest sand fields occur in the Kara Kum, Kyzyl Kum, Takla Makan and Gobi deserts.

*Su*10 Disintegrated rock deposits or desert pavements (desert detritus, hamadas) occur in the Gobi, where they represent desert surfaces of consolidated clastic sedimentary rocks or sometimes limestones. The rock debris usually cover the hard base surface in a thin sheet, but may accumulate in great thicknesses in depressions.

*Sc*1 Consolidated clastic sediments occur in large areas of the Ust Urt plateau, the Turgai tableland, Kazakhstan, the central Asian plateau and the eastern Siberian mountains. They are of various geological ages and include many different kinds of rocks ranging from sandstones and clay shales to conglomerates. Where they are shown on the map, they usually do not cover the whole area of a given region, but outcrop on mountain or hill slopes, the valleys and foothills being covered by fluvial deposits.

*Sc*2 Consolidated carbonate sediments occur mostly in the southern Urals, the Anabar massif, the Kunlun range, Tibet, the Himalayas and the mountains of southwestern China. The limestones of this great mountain belt are of different geological ages, ranging from the lower Paleozoic to the upper Mesozoic. Usually, the limestones are interbedded with clay shales and sandstones and vary greatly in colour and texture. Dolomites and marls are common.

*Sc*3 Purple clay shales and sandstones characterize the Red basin region of China. They are believed to represent a product of Tertiary weathering of bedrock. The soils formed on these parent materials are of dark red to purple and even violet colour.

*M*1 Various metamorphic rocks occur widely in the mountains of North and Central Asia. They characterize the Byrranga, Yenisei and Yudom-Maya regions, the eastern and Mongolian Altai, Japan, the Tien Shan, Karakoram, Nan Shan and Ch'in Ling ranges, and the mountains of southwestern China. Gneisses, phyllites, quartzites and schists of varying mineralogical composition predominate.

*M*2 Granitized and migmatized basement rocks, including granites, gneisses and migmatites, outcrop in the Anabar and Aldan shields and the Korean and Shantung mountains. They are the most ancient rocks of the continent.

*I*1 Acid intrusive rocks occur widely in North and Central Asia, being represented mostly by various granites. They mainly characterize the eastern part of the continent, but also occur on its western edge in the southeastern Urals and in the Kazakh upland. Intrusive granites predominate in Transbaikalia, where they form almost entire mountain ranges. Granite outcrops quite often among sheets of clastic sediments in the central Asian plateau.

*I*2 Basic intrusives are less well represented in the continent. They outcrop in the northern Urals and occur in places among the intrusives of the eastern Siberian mountains.

*E*1 Acid effusives, including rhyolites, porphyries and dacites, are common in the eastern Siberian mountains, where they outcrop among other sedimentary and intrusive rocks. They are uncommon in other parts of the continent. In Figure 5 this lithological type is indicated by an overprint on type *Sc*1.

*E*2 Basic effusives are more widespread, occurring in rather large areas. The largest field of basaltic traprock is the central Siberian plateau, but these rocks also occur in many places in the central Asian plateau and in the eastern mountains, including the Greater Khingan, Sikhote Alin and Kamchatka ranges, and in Japan. All are of different geological ages, from the oldest in central Siberia to the youngest in the Kamchatka range and Japan.

*E*3 Recent volcanic tuff and ash occur in the volcanic Pacific Ocean belt of Asia, i.e. in the Kamchatka Peninsula and in the Kuril Islands and Japan. They represent a very specific parent material on which Andosols are formed. In Figure 5 this lithological type is indicated by an overprint on type *E*2.

Each of the broad geological and geomorphological regions of North and Central Asia is characterized by its own pattern of surface lithology, as can be seen on the lithological map. The parent rocks greatly contribute to the complex pattern of soil geography of the continent. Together with the relief forms, they determine the pattern of the broad soil regions which will be described in the following chapter.

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5. THE SOILS OF NORTH AND CENTRAL ASIA

The legend of the Soil Map of North and Central Asia consists of 425 map units in 328 different soil associations, each of which is composed of one or more soils occupying characteristic positions in the landscape. The sequence of their occurrence is related to climate, topography, geomorphology and lithology.

Each soil association is characterized by the dominant soil (the soil with the largest extension), and by associated soils covering more than 20 percent of the area and inclusions having a lesser extension. Sixty-six dominant soils have been indicated on the map.

For convenience and brevity, the soil associations have been listed in Table 4, which contains information on the dominant soils, their texture and slope class, associated soils and inclusions, phases, an estimate of the unit area, climate symbols as described by J. Papadakis (1966), and countries of occurrence.

Distribution of major soils

The environment of North and Central Asia is extremely varied, ranging from the polar belt and the world's northern cold pole at Verkhoyansk to near-tropical conditions in Hainan, and from the Gobi and Takla Makan deserts to the luxurious evergreen forests of Southeast Asia. The topography is also varied, ranging from sea-level lowlands to the world's highest peaks in the Himalayas. This diversity of environmental conditions is reflected in a very complex soil pattern. However, some general natural patterns of soil geography related to the general physiography of the surface may be observed.

In order to simplify the continent's soil geography, it has been divided into four broad soil-bioclimatic belts, each of which has been subdivided into soil-bioclimatic provinces, then into soil zones or subzones, and finally into soil regions of more or less uniform soil cover. Altogether there are 64 plains soil regions (lowlands and uplands) and 49 mountain soil regions which total 113 soil regions and reflect the enormous diversity of the continent's soil pattern. The soil regions are shown on a small-scale map (Figure 6) and listed in Table 5. All soil regions are ecological regions with a characteristic climate, vegetation, soil pattern and specific agricultural potential. The basic principle of soil regioning was taken from the Soviet system (Academy of Sciences of the U.S.S.R., 1962). For the area of the U.S.S.R. this soil regioning system was taken as outlined, and for other parts of the continent it was extrapolated.

SOIL REGIONS OF THE POLAR BELT

A. *Eurasian polar province*

This large province is the only one in the polar belt, as data for its subdivision are insufficient at present. It extends from the Yamal Peninsula to the Chukotski Peninsula along the north coast of the continent for more than 3 000 kilometres and comprises two soil zones (the arctic zone of Gelic Gleysols and Gelic Regosols, and the subarctic zone of Gelic Gleysols), and three mountain soil regions (northern Ural, Chukchi and Taimyr) with specific montane arctic and tundra landscapes.

A1. Arctic zone of Gelic Gleysols and Gelic Regosols

This zone is regarded as a single soil region despite its enormous extension. It includes the islands of the Arctic Ocean which belong chiefly to the region of arctic wastes, and the coastal areas of the arctic tundra region occurring on post-glacial marine terraces and glacial plains composed of loose sediments left by fluvioglacial deposition, and at the foot of mountains composed mostly of sedimentary Paleozoic and Mesozoic hard rocks.

The arctic wastes have a sparse vegetation comprising a few species of grasses, herbs, mosses and lichens. Cryoturbations have broken the soil surface into polygons, and stony rings are also common. The dominant Gelic Regosols occur in association with some Gelic Gleysols and Gelic Histosols. In river deltas there are moss marshes and meadows. The soils are often calcareous and saline because of very limited leaching. Annual production of green plant mass is only about 400 kg per hectare. The

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Af50-3bc	I		Lithic	12 172	9.81-7.53-2.25-2.32	China
Af50-3c	I		Lithic	761	9.81-2.32	China
Af52-3b		Ag Jd		16 375	9.81-7.53-4.12-8.15-8.16-8.11	China
Af62-2/3b		I		4 141	4.12-7.53	China
Af63-3c	I	Ap		11 663	2.25-4.12-1.22-1.23-4.11	China
Ao13-3bc	I			61 763	7.53-2.25-8.15-2-4.12-8.11-2.32-4.18	China
Ao18-3bc	I Lc			15 238	9.81-7.53-2.32-4.12-8.15-8.11	China
Ao41-2ab	Bd			328	2.32	China
Ao43-2/3b		I		47	7.53	Rep. of Korea
Ao76-2/3c	I Nd	Ah	Lithic	364	9.81-2.32	China
Ao80-2bc	Ah Pl	Bh Dd		101	10.57	China
Ao84-2/3b	Bf	G R		73	—	Japan
Ao84-2/3b	Bf	G R		2 596	8.16	Rep. of Korea
Ao84-2/3b	Bf	G R		217	8.23-8.16	Dem. People's Rep. of Korea
Ao85-2/3b	Be	Af T		1 486	8.11	Japan
Ao86-3b	Af	T		4 129	4.11-8.11-8.13	Japan
Ao87-3b	Af			312	1.61-4.11	Japan
Ao88-3b	To	Af		233	8.11-8.21	Japan
Ao90-2/3c		Ah Bd I	Lithic	5 646	2.32-2.25-4.12-1.23	China
Ao107-2bc	Af Nd	Bf I		390	2.25-4.12	China
Bc21-2b	Bk			75	6.78	U.S.S.R.
Bc28-2b				13 896	8.26-8.23-9.87-9.82-9.83-9.88-8.18	China
Bc49-3bc	Lc Bk	Re I		4 437	7.53-4.18	China
Bc50-2/3ab	Lc Re			6 292	4.18-7.53	China
Bd3-2ab				1 254	8.33-9.81	U.S.S.R.
Bd3-2b				496	8.11-8.16-10.12	Rep. of Korea
Bd3-2b				109	8.21	Dem. People's Rep. of Korea
Bd34-2bc	Ao Dd I	Bh Bc G O	Stony	33	10.57	China
Bd36-1ab	Gd	Dd	Phreatic	2 331	10.17	U.S.S.R.
Bd36-2ab	Gd	Dd	Phreatic	919	10.17	U.S.S.R.
Bd36-2b	Gd	Dd	Phreatic	7 803	10.17-8.32	U.S.S.R.
Bd37-2b	Be Bh			90	9.87-8.18	China
Bd38-2b	Ao To	Af		467	7.51-7.61	Japan
Bd39-2b	To	Af Ao Tv		1 284	7.51-8.21-8.11	Japan
Bd40-2bc	Ao I	Af		95	4.11	Japan
Be1-2b				1 161	8.23	Dem. People's Rep. of Korea
Be13-2bc	I			315	7.65	Japan
Be86-2b	Bg Lg			1 096	8.21-8.23	Dem. People's Rep. of Korea
Be87-2ab		G J		115	8.23	Dem. People's Rep. of Korea

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Be88-2/3b		T		3 755	8.11-7.51-8.13-8.21-8.23	Japan
Be118-2bc	Ao I	G		1 205	8.16	Rep. of Korea
Bf14-2b	Be			163	8.23	Dem. People's Rep. of Korea
Bf15-2b	Af Ao			101	8.16	Rep. of Korea
Bg3-1ab	Gd	Pg		6 116	10.17	U.S.S.R.
Bg3-2b	Gd	Pg		624	10.17	U.S.S.R.
Bg4-1ab	Gd Od	Pg		400	10.17	U.S.S.R.
Bg4-2ab	Gd Od	Pg		140	10.17	U.S.S.R.
Bg5-2ab	Bd Oe	Dg		1 400	9.8-10.18	U.S.S.R.
Bg6-2a	Bd	Dg		197	8.32-10.12-9.81	U.S.S.R.
Bg6-2ab	Bd	Dg		3 376	8.32-10.18	U.S.S.R.
Bk36-2b	Lo Xk	Rc		5 011	9.89-9.83	China
Bk41-2b	Xk			149	6.78	U.S.S.R.
Bk42-2b	Xh			9 419	9.83-9.82-8.15-8.16	China
Bk44-3a	Xk	Gc Jc		2 453	9.83	China
Bx1-1b				272	10.19	U.S.S.R.
Bx1-2b				16 961	10.12-10.19	U.S.S.R.
Bx3-2a	Gx Rx			9 961	10.18-10.25-10.24	U.S.S.R.
Bx3-2b	Gx Rx			1 833	10.25	U.S.S.R.
Bx4-2a	Gx Od Rx			57 557	10.19-10.22-10.25-10.17	U.S.S.R.
Bx4-2b	Gx Od Rx			5 997	10.25-10.17	U.S.S.R.
Bx4-2b	Gx Od Rx		Stony	2 451	10.25	U.S.S.R.
Bx5-3a	Gx			3 776	10.19-10.25	U.S.S.R.
Bx6-3b	Bk Rc			10 815	10.24-10.25	U.S.S.R.
Bx7-2ab	Gx Oe Rx			21 417	10.19-10.25-10.24	U.S.S.R.
Bx8-2b	Gd			19 692	10.19-10.25	U.S.S.R.
Bx8-2b	Gd		Stony	8 104	10.19-10.25	U.S.S.R.
Bx9-2ab	Gd Od			7 910	10.19-10.25-10.17	U.S.S.R.
Bx9-2b	Gd Od		Stony	1 057	10.25	U.S.S.R.
Bx10-2ab	Gd Oe			1 537	10.19-10.25	U.S.S.R.
Bx11-2/3b	Od			34 256	9.35-10.19-10.25	U.S.S.R.
Bx12-2ab	Bk Ws			5 418	9.35-10.19	U.S.S.R.
Bx13-2ab	Bk Sg Ws			1 788	9.35-10.19	U.S.S.R.
Bx14-2ab	Bk Gm Ws	Sg		5 045	10.19	U.S.S.R.
Bx15-2ab	Bk Od Ws			821	9.35-10.19	U.S.S.R.
Bx16-2ab	Bk Gm Ws			1 173	10.19	U.S.S.R.
C1-3a			Phreatic	184	9.72	China
C1-3a			Phreatic	11 579	9.31-8.32-10.12-9.32-9.34	U.S.S.R.
C2-3a	Ws		Phreatic	1 039	9.34	U.S.S.R.
C3-3a	Gx		Phreatic	205	10.53	Mongolia
C3-3a	Gx		Phreatic	1 701	9.81-10.18-10.17	U.S.S.R.
C4-3a	Gm Oe		Phreatic	1 030	8.33	U.S.S.R.
Cg2-3a	Ck			776	10.17-9.32-9.34	U.S.S.R.

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Cg3-3a	Ch Jc			454	9.81-10.17	U.S.S.R.
Cg4-3a	Ch	Je		114	9.81	Mongolia
Cg4-3a	Ch	Je		2 328	9.81	U.S.S.R.
Cg6-3a	Ch			2 066	9.35-10.17-9.32-9.34	U.S.S.R.
Ch1-3a				8 779	9.34-9.31-10.12-9.33-9.32	U.S.S.R.
Ch14-3a	Ws			7 056	9.33-9.32	U.S.S.R.
Ch15-3a	Sm	Gm Sg		833	9.33-9.32	U.S.S.R.
Ch16-3a	Sm			212	9.32	U.S.S.R.
Ch17-3a	Sm Ws	Gm Sg		3 689	9.32	U.S.S.R.
Ch18-3a	Cg Gm			1 396	8.26	China
Ch19-3a	Gm	Zg		38	3.72	Mongolia
Ch19-3a	Gm	Zg		4 286	8.26-9.82-9.81-3.72	China
Ch20-2/3ab	Gm Kh	I		1 775	9.89-3.73-10.57	China
Ck1-2a				1 773	9.33-9.32	U.S.S.R.
Ck1-2ab			Lithic	391	9.33-9.72	U.S.S.R.
Ck1-3a				11 579	9.72-9.33	U.S.S.R.
Ck1-3ab			Lithic	579	9.72	U.S.S.R.
Ck1-3b				36	10.54	China
Ck1-3b				152	9.33	U.S.S.R.
Ck3-3a	Gm			355	9.33	U.S.S.R.
Ck4-3a	Sm			433	9.33-9.32	U.S.S.R.
Ck5-3a	Oe Sm	Gm		1 245	9.33	U.S.S.R.
Ck6-3a	Ws			1 000	9.33-9.32	U.S.S.R.
Ck7-3a	Sm Ws	Gm		1 728	9.32	U.S.S.R.
Ck8-3a	Sm	Gm		427	9.32	U.S.S.R.
Cl1-3a				10 806	9.34-9.31-8.32-9.32	U.S.S.R.
Cl8-3a	Ws			1 761	9.32	U.S.S.R.
Cl9-3a	Gx		Phreatic	4 042	10.18-9.34-10.17-9.32	U.S.S.R.
Dd1-1ab	Gd			660	10.17	U.S.S.R.
Dd1-2ab	Gd			2 534	10.17-8.32-9.34	U.S.S.R.
Dd1-2b	Gd			10 883	10.11-8.32-10.12-10.17-10.25	U.S.S.R.
Dd2-2b	Gd Od			17 474	10.19-9.35-9.34-10.17-10.25	U.S.S.R.
Dd3-2b	Dg Gd			2 534	10.17-8.32	U.S.S.R.
Dd4-2c	Bd I			79	7.71	Japan
De5-2ab	Gd			5 555	9.32-8.32	U.S.S.R.
De5-2b	Gd			3 755	9.34-8.32-10.17	U.S.S.R.
De6-2ab	Dg Gd	Gh		3 642	8.32-9.34	U.S.S.R.
De6-2b	Dg Gd	Gh		660	8.32	U.S.S.R.
De7-2ab	Gd	Gh		2 531	9.34-10.17-8.32	U.S.S.R.
De7-2b	Gd	Gh		1 582	8.32	U.S.S.R.
De8-2ab	Dg Oe	Gh		2 194	8.32-9.32	U.S.S.R.
De9-2ab	Gc Ge			7 740	8.32-9.34	U.S.S.R.
De10-2ab	Gd Od			2 713	10.18-10.94-9.34-10.17-10.19	U.S.S.R.

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
De11-2b	Dg Gd	Ge Gh		883	9.34	U.S.S.R.
De12-2ab	Dg Gd Od	Gh Mg		2 624	9.34	U.S.S.R.
Dg2-1ab	Gd	Gh		13 543	10.17	U.S.S.R.
Dg2-2ab	Gd	Gh		1 651	10.17-9.34	U.S.S.R.
Dg2-2b	Gd	Gh		1 815	10.17-8.32	U.S.S.R.
Dg3-2a	Gd Gh			4 182	8.34-8.32-9.34	U.S.S.R.
Dg3-2ab	Gd Gh			2 609	10.11-8.32-7.71-10.18 10.17-10.25-9.35	U.S.S.R.
Dg4-2ab	Gd Od	Gh		3 710	10.17-8.32-9.34	U.S.S.R.
Gc4-3a	Jc	Zg	Saline	4 057	3.71-6.79-6.78	U.S.S.R.
Gc5-3a	Jc Zo Zt	Zg	Saline	1 283	3.71	U.S.S.R.
Gc10-1a	Jc			5 758	8.18-9.11-9.87-8.16	China
Gd23-1ab	Bg	Gx Pg		15 020	10.17	U.S.S.R.
Gd23-2ab	Bg	Gx Pg		1 582	10.17	U.S.S.R.
Gd24-1ab	Bg Od	Gx Pg		6 871	10.17	U.S.S.R.
Gd24-2ab	Bg Od	Gx Pg		746	10.17	U.S.S.R.
Ge10-2a	Zg			122	9.72	U.S.S.R.
Ge10-3a	Zg		Saline	304	3.73	Mongolia
Ge10-3a	Zg		Saline	104	10.53-3.72	U.S.S.R.
Ge39-3a	Zg	Je Oe	Saline	1 167	3.71-3.72	U.S.S.R.
Ge40-3a	Gc Je	Zg	Saline	1701	9.72-6.78-3.72-3.71	U.S.S.R.
Ge41-3a	Gc Zg		Saline	146	3.71	U.S.S.R.
Ge42-3a	Gc			42	9.33-9.72	U.S.S.R.
Ge43-2a	Gm		Saline	90	3.72	China
Ge43-3a	Gm		Saline	1 874	6.78-3.72-3.71	U.S.S.R.
Ge43-3a	Gm		Saline	321	9.73-3.72	China
Ge46-2a		Zg		421	6.75-3.72	U.S.S.R.
Ge48-2/3a		Je		385	8.16-7.53	Rep. of Korea
Ge48-2/3a		Je		64	8.23	Dem. People's Rep. of Korea
Ge49-2/3a	Gm Je Oe	Re		931	8.11-8.12-8.23-7.65	Japan
Ge60-2/3a	Gm Lg	Gd Jd		8 958	8.16-8.11-8.15	China
Ge61-3a	Zg	Gm Jc	Saline	2 630	9.89-3.72-9.83-1.23	China
Ge62-2/3a	Gm Lg	W Je		26 126	8.16-8.12-8.11-8.15-7.53-4.12-4.18	China
Ge63-2/3a	Gm Lp	Jc Jt		5 714	4.12-1.23-1.22-4.11	China
Gh13-2a	Gd			2 597	8.32-9.34	U.S.S.R.
Gh14-2a	De Ge	Gc Gd		2 833	9.34	U.S.S.R.
Gm 3-3a				63	9.72	U.S.S.R.
Gm16-1/2a	Ge			144	9.73	China
Gm16-3a	Ge			3 131	9.72	U.S.S.R.
Gm17-3a	Ws			331	9.34	U.S.S.R.
Gm18-3a	Gc Sm	Jc Je		1 418	9.72-9.33	U.S.S.R.
Gm19-3a		Ge		573	9.81	U.S.S.R.
Gm20-2/3a	Ge Je			675	8.32-8.26	U.S.S.R.
Gm20-2/3a	Ge Je			17 493	8.32-10.12-8.33-9.81-9.82-10.18-9.89-8.26	China

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Gm23-2/3a	Ge Zg	Jc Je	Saline	2 046	3.72-9.83	China
Gm25-2/3a	Jc Ge	Zg	Saline	34	8.23	Dem. People's Rep. of Korea
Gm25-2/3a	Jc Ge	Zg	Saline	20 426	8.12-9.89-9.87-8.18-9.82-9.11-8.26-8.23-9.88-8.16	China
Gm26-2/3a	Zg	Jc	Saline	5 231	9.88-9.87-8.26	China
Gm27-3a	Jc Ge	Bc V		3 348	9.11-8.16-8.18	China
Gm28-2/3a	Zo		Saline	263	9.11-8.18	China
Gx3-2ab	Rx			13 552	10.22-10.24-10.3-10.27	U.S.S.R.
Gx6-2a	Od Oe Rx			3 263	10.27-10.24	U.S.S.R.
Gx7-2a	Od	Ox Rx		12 791	10.19-10.17-10.25-10.22	U.S.S.R.
Gx8-1ab		Gx Ox Rx		1 035	10.22	U.S.S.R.
Gx8-2ab		Gx Ox Rx		60 473	10.19-10.12-10.25-10.21-10.22-10.24-10.17	U.S.S.R.
Gx9-2a	Oe	Ox Rx		719	10.22-10.24	U.S.S.R.
Gx9-2ab	Oe	Ox Rx		20 805	10.24	U.S.S.R.
Gx10-2ab	Od Rx			27 366	10.24-10.3-10.2	U.S.S.R.
Gx11-2a	Oe Rx			3 427	10.22-10.24	U.S.S.R.
Gx12-2a	Je Oe Rx			2 740	10.24	U.S.S.R.
Gx13-2a	Od Oe	Ox Rx		1 886	10.22	U.S.S.R.
Gx14-2ab	To	Ox Rx		806	10.17-10.25	U.S.S.R.
Hg6-2/3a	Gm Lg	Jc		197	10.12-8.21	Dem. People's Rep. of Korea
Hg6-2/3a	Gm Lg	Je		5 209	8.32-8.26-10.12	China
Hh20-2/3a	Hg	I		1 515	9.82-10.12-8.33	China
Hh21-2/3a	Hg	Zm		9 304	9.82-8.26-10.12	China
Hh22-2/3a	Hg Zm			1 948	8.26-9.82	China
I-Af-3c				15 776	2-4.12-7.53-2.25-1.22	China
I-Af-3c			Lithic	1 515	9.81	China
I-Af-Bd-2c			Lithic	3 799	9.81-10.57	China
I-Af-Bd-2c			Rock debris	8 027	9.83-8.16	China
I-B-U-2c				783	10.57	China
I-Bc-2c				14 675	7.53-2-9.82	China
I-Bc-2c			Rock debris	11 353	7.53-9.83-9.81-8.15-9.89	China
I-Bc-2c			Rock debris	5 173	6.79-10.54-6.91-3.71-6.78-10.57	U.S.S.R.
I-Bc-Bh-c			Rock debris	122	6.79	U.S.S.R.
I-Bc-Bh-2c			Rock debris	476	10.54-9.72	China
I-Bc-Bh-2c			Rock debris	782	10.54-9.72-6.75	U.S.S.R.
I-Bd-Bh-c				61	—	Rep. of Korea
I-Bd-2c			Lithic	3 245	8.16	Rep. of Korea
I-Bd-Bx-Dd-2c			Lithic	25 910	10.18-10.19-10.94-10.12-10.17-10.53	U.S.S.R.
I-Bd-Dd-2c			Lithic	6 913	10.11-8.32-10.12-10.18-10.25-10.53	U.S.S.R.

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
I-Bd-Dd-Ph-2c			Lithic	8 761	8.32-10.12-9.81	U.S.S.R.
I-Bd-Lo-To-2c			Lithic	7 236	7.61-8.21-7.71-7.62-8.23-7.65	Japan
I-Bd-T-2c			Lithic	5 195	1.61-8.11-7.51-7.61-8.21	Japan
I-Be-2c			Lithic	4 077	10.12-8.21-8.23	Dem. People's Rep. of Korea
I-Be-2c			Lithic	4 874	8.32-10.12-10.53	U.S.S.R.
I-Be-2c			Rock debris	681	10.12-6.78	U.S.S.R.
I-Be-2c				14 228	9.82-9.87-8.26-8.18	China
I-Be-2c			Lithic	1 533	8.16	Rep. of Korea
I-Be-2c			Lithic	5 162	9.81-8.23-8.26	China
I-Be-2c			Lithic/rock debris	1 147	9.81-2.32	China
I-Be-2c			Rock debris	14 553	9.89-9.81-10.57-8.16-7.53-9.83	China
I-Be-Lo-2c			Lithic/rock debris	47	10.12	Rep. of Korea
I-Be-Lo-2c			Lithic/rock debris	1 446	10.12-8.23-8.16	Dem. People's Rep. of Korea
I-Be-T-2c			Lithic	445	10.12	Dem. People's Rep. of Korea
I-Bh-c			Rock debris	123	10.54-10.57	U.S.S.R.
I-Bh-2c			Rock debris	9 380	3.72-10.54-10.57-9.89	China
I-Bh-2c			Rock debris	148	10.57	Mongolia
I-Bh-2c			Rock debris	11 641	10.54-9.72-10.12-10.57	U.S.S.R.
I-Bh-Dd-2c			Lithic	502	7.61	Japan
I-Bh-U-c			Lithic/rock debris	103	10.57	Mongolia
I-Bh-U-c			Lithic/rock debris	13 135	10.57	China
I-Bh-U-c			Lithic/rock debris	1 203	10.53-10.57	U.S.S.R.
I-Bh-U-2c				1 176	10.57	China
I-Bh-U-2c			Stony	527	10.57-9.81	China
I-Bh-U-2c			Lithic/rock debris	6 309	10.57-10.53	Mongolia
I-Bh-U-2c			Lithic/rock debris	24 939	10.57-3.72-10.54-9.81	China
I-Bh-U-2c			Lithic/rock debris	3 361	10.53-10.54	U.S.S.R.
I-Bk-2bc				9 282	9.81-9.82-10.12-8.26-2	China
I-Bk-2bc			Rock debris	527	9.83	China
I-Bx-Dd-2c			Lithic	38	10.53	Mongolia
I-Bx-Dd-2c			Lithic	149 581	10.25-10.12-10.19-10.17-10.24-9.35	U.S.S.R.
I-Bx-Dd-Od-2bc			Lithic	8 540	10.25	U.S.S.R.
I-Bx-Rc-2c			Lithic	25 981	10.18-10.25-10.12-10.19	U.S.S.R.
I-C-2c				142	9.89	Mongolia
I-C-2c				5 224	9.89-9.81-3.72	China
I-C-2c			Lithic	635	9.81	China
I-C-2c			Lithic	4 361	10.53-9.22-10.22-9.33-9.32	U.S.S.R.
I-C-2c			Rock debris	282	9.72-9.73	China
I-C-2c			Rock debris	2 388	9.22-9.33-6.75-10.54-9.72	U.S.S.R.
I-C-3c			Lithic	421	9.81	U.S.S.R.
I-C-3c			Rock debris	57	6.79	U.S.S.R.

TABLE 4. - SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
I-Dd-c			Lithic/rock debris	683	10.12	U.S.S.R.
I-Dd-2c			Lithic	187	10.12	Dem. People's Rep. of Korea
I-Dd-2c			Lithic	9 997	10.18-9.81	China
I-Dd-2c			Lithic	69 419	10.11-8.32-10.12-10.25-9.8-10.18-10.19-10.14.-10.17-9.34-10.53-9.31-10.22-8.31	U.S.S.R.
I-Dd-Lo-2c			Lithic	113	8.21	Japan
I-Dd-Lo-To-2c			Lithic	1 845	7.51-7.61-8.12	Japan
I-Dd-Ph-2c			Lithic	7 307	10.12-10.18	U.S.S.R.
I-Dd-Rd-2c			Lithic	5 663	10.57-9.81-10.53	Mongolia
I-Dd-Rd-2c			Lithic	28	10.18	China
I-Dd-Rd-2c			Lithic	25 787	10.18-10.94-9.34-10.17-10.19-9.35-10.53	U.S.S.R.
I-Gm-2c				357	10.57-9.89	China
I-Gx-2c			Rock debris/saline	16 079	10.57	China
I-Gx-2c			Rock debris/saline	251	10.57	U.S.S.R.
I-Gx-Rx-c			Lithic/rock debris	11 829	10.22-10.24-10.3	U.S.S.R.
I-Gx-Rx-2c			Lithic	98	10.57	China
I-Gx-Rx-2c			Lithic	973	10.53	Mongolia
I-Gx-Rx-2c			Lithic	128 689	10.11-10.12-10.25-10.18-10.15-10.21-10.22-10.24-10.53-10.17	U.S.S.R.
I-H-2c			Rock debris	7 100	10.57-3.73	China
I-K-c			Rock debris	370	9.72-3.72	U.S.S.R.
I-K-2c				63	9.89	Mongolia
I-K-2c				8 802	3.72-9.83-9.82-9.89-9.81	China
I-K-2c			Rock debris	25 927	10.57-3.73-9.81-10.53-9.89	Mongolia
I-K-2c			Rock debris	22 825	3.73-10.57-9.89-9.72-9.73	China
I-K-2c			Rock debris	9 400	10.17-10.53-9.73-9.33-6.75-9.72-6.79-3.72-9.32	U.S.S.R.
I-K-U-1/2bc				3 528	9.89-9.82	China
I-K-U-2c				188	2	China
I-K-U-2c			Rock debris	7 886	10.57-9.81	China
I-K-U-2c			Rock debris	764	10.54	U.S.S.R.
I-K-U-2c			Lithic/rock debris	19 661	10.57	China
I-Lc-Bk-c				22	2.25	China
I-Lo-2c			Lithic	2 509	10.12	Dem. People's Rep. of Korea
I-Lo-2c			Lithic	22 608	9.81-10.18-10.12-9.82-8.33-8.32	China
I-Lo-2c			Lithic	8 770	8.32-7.71-10.12	U.S.S.R.
I-Mo-2c				3 030	9.89-9.81	China
I-Mo-2c			Lithic	570	10.57	China
I-Mo-2c			Lithic	8 437	10.50-9.81-10.53	Mongolia

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
I.Mo-2c			Lithic	10 680	9.81-10.17-10.53-9.22-8.32-10.12-8.31-9.32	U.S.S.R.
I-Mo-2c			Rock debris	116	10.17	U.S.S.R.
I-T-c			Lithic	9 737	10.12	U.S.S.R.
I-U-c				142	7.71	Japan
I-U-c				63	10.12-10.57	U.S.S.R.
I-X-c			Rock debris	170	6.78	U.S.S.R.
I-X-2c			Rock debris	38 954	10.57	China
I-X-2c			Rock debris	2 355	10.57	U.S.S.R.
I-Xk-2c			Rock debris	5 424	6.79-10.54-6.78-3.71-6.91	U.S.S.R.
I-Xl-2c			Rock debris	5 564	10.57-3.72	Mongolia
I-Xl-2c			Rock debris	10 159	3.72-10.57	China
I-Xl-2c			Rock debris	—	9.72	U.S.S.R.
I-Y-2c			Rock debris	55 718	10.57	China
I-Y-2c			Rock debris	2 349	10.54-10.57	U.S.S.R.
I-Yh-2c				3 745	3.72	China
I-Yh-2c			Rock debris	1 900	10.57-3.72	Mongolia
I-Yh-2c			Rock debris	15 007	3.72-3.71	China
I-Yk-2c				6 876	3.72-3.73	China
I-Yk-2c			Rock debris	—	3.72	Mongolia
I-Yk-2c			Rock debris	3 333	3.72-9.89-9.83	China
J2-2a	G			255	9.81	Mongolia
J2-2a	G			98	8.23	Dem. People's Rep. of Korea
J2-2a	G			1 090	8.32-8.33	China
J2-2a	G			3 734	8.32-8.33-9.81-10.18-10.17-10.24-9.31	U.S.S.R.
Jc1-2a				401	9.72	China
Jc1-2a				1 585	9.72-6.75-3.72	U.S.S.R.
Jc53-2a		Zg		54	3.72	U.S.S.R.
Jc53-2a		Zg	Saline	1 203	3.71-6.78	U.S.S.R.
Jc54-2a	Y Zg	Oe		7 763	3.71	China
Jc55-2ab	Bk			6 927	9.81-10.57-1.23	China
Jc56-2a	Ge Gm			3 351	9.87-9.11	China
Jd7-2a	Gd Gh	Ge Gm Je		25 166	10.19-10.22-10.24-9.34-9.73-10.17-9.32-8.32	U.S.S.R.
Je2-1a			Shifting sand	42	9.72	U.S.S.R.
Je2-2a				645	10.53-9.72	U.S.S.R.
Je12-2a	Ge Gm			7 262	8.32-9.31-9.33-9.32	U.S.S.R.
Je13-2a	Ge			546	9.81-10.17	U.S.S.R.
Je78-2a		Zg		824	3.72-9.72	U.S.S.R.
Je78-2a		Zg	Saline	1 797	3.71-3.72	U.S.S.R.
Je79-2/3a	Ge Gm	Oe		1 807	8.11-8.13-8.21-7.62-7.65	Japan
Je79-2a	Ge Gm	Oe		6 671	9.35-10.19-10.12-10.22	U.S.S.R.

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Je80-2a	Gm Jc	Ge Zg		162	9.72	China
Je80-2a	Gm Jc	Ge Zg		1 561	9.22-9.73-9.72	U.S.S.R.
Jc81-a	Ge Gm Re			347	8.21	Japan
K1-2a			Phreatic	113	9.72	U.S.S.R.
K1-3a			Phreatic	354	9.72	China
K1-3a			Phreatic	75	9.72	U.S.S.R.
Kh1-1ab			Sodic	5 113	9.33	U.S.S.R.
Kh1-2a			Sodic	4 534	9.72-9.33	U.S.S.R.
Kh1-2ab				1 144	9.81	Mongolia
Kh1-2ab			Sodic	716	9.72-9.33	U.S.S.R.
Kh1-2ab			Sodic/lithic	2 567	9.72	U.S.S.R.
Kh1-2b				4 159	10.57-3.73	Mongolia
Kh1-2b				16 075	9.81-9.89-3.72-9.83-8.26	China
Kh1-2b				2 418	9.81-10.94-10.17-10.53-9.22-9.72	U.S.S.R.
Kh1-2b			Sodic	144	9.72	China
Kh1-2b			Sodic	1 080	9.22-9.72	U.S.S.R.
Kh1-2b			Sodic/lithic	4 427	9.33-9.32	U.S.S.R.
Kh1-2b			Sodic/stony	1 710	9.72-9.33	U.S.S.R.
Kh24-2b	Zo			888	9.81	China
Kh24-2b	Zo			5 179	3.73-9.81	Mongolia
Kh24-2b	Zo			836	9.81	U.S.S.R.
Kh25-1/2a	So		Sodic	1 854	9.72	U.S.S.R.
Kh25-2a	So		Sodic	10 480	9.72-9.33	U.S.S.R.
Kh25-2b	So		Sodic/lithic	131	9.72	U.S.S.R.
Kh26-2a	Gm So Zo		Sodic	4 301	9.72-9.33	U.S.S.R.
Kh27-2a		Gm	Sodic	6 516	9.72-9.33	U.S.S.R.
K14-1a			Sodic	251	9.72	U.S.S.R.
K14-1ab			Sodic/lithic	1 054	9.72	U.S.S.R.
K14-1b				170	9.33	U.S.S.R.
K14-1/2ab			Sodic	1 003	3.72-9.72	U.S.S.R.
K14-2a			Sodic	180	9.72	China
K14-2a			Sodic	1 292	9.22-9.72-3.72	U.S.S.R.
K14-2ab			Sodic	119	9.72	U.S.S.R.
K14-2ab			Sodic/lithic	746	3.72-9.72	U.S.S.R.
K14-2b				458	9.72	China
K14-2b				2 645	3.73	Mongolia
K14-2b				594	10.53-9.72	U.S.S.R.
K14-2b			Sodic/stony	2 889	9.72-9.33	U.S.S.R.
K14-2b			Sodic/lithic	149	3.72-9.72	U.S.S.R.
Kl11-1a	So		Sodic	2 519	9.72	U.S.S.R.
Kl11-1ab	So		Sodic/lithic	263	9.72	U.S.S.R.
Kl11-2a	So		Sodic	1 024	3.72-9.72	U.S.S.R.
Kl11-2ab	So		Sodic	448	9.72	U.S.S.R.
Kl11-2ab	So		Sodic/lithic	1 454	9.72-9.33	U.S.S.R.

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Kl11-2b	So		Sodic/stony	1 042	9.72	U.S.S.R.
Kl36-1/2a	So	Gm	Sodic	3 698	9.72	U.S.S.R.
Kl36-2a	So	Gm	Sodic	125	9.33-9.72	U.S.S.R.
Kl36-3a	So	Gm	Sodic	3 507	9.72	U.S.S.R.
Kl37-3a	Gm	So	Sodic	4 782	9.72-9.33	U.S.S.R.
Kl38-1ab	So	Zo	Sodic	167	9.72	U.S.S.R.
Kl38-2b	So	Zo	Sodic	848	9.72	U.S.S.R.
Kl39-1a	Zo		Sodic	179	9.72	U.S.S.R.
Kl39-2b	Zo			30 849	10.57-3.73-9.81-9.89-3.72	Mongolia
Kl39-2b	Zo			9 888	9.83-3.72	China
Kl40-1a	So Zo		Sodic	2 836	9.72	U.S.S.R.
Kl41-1a	Gm		Sodic	866	9.72	U.S.S.R.
Kl42-2b	Gm So		Sodic/lithic	806	3.72	U.S.S.R.
Kl43-1a	Kh Qc			5 292	3.72	China
Kl43-1a	Kh Qc			82	3.72-8.26	Mongolia
Kl44-2/3ab	Kh	Gm Zm		3 294	9.83-9.82-8.26	China
Lc101-2a	Lo	I Je		3 712	9.83-8.16-9.11-9.81-8.18-9.87	China
Lf32-3bc		I	Petric	2 695	2.25-4.12-1.23-1.22-2	China
Lg1-2ab				460	9.81	U.S.S.R.
Lg1-2b				40	8.32	China
Lg1-2b				11 444	8.32-7.71-7.52-8.25-10.12-8.33-9.81	U.S.S.R.
Lg15-2ab	We			2 006	8.33-9.81-9.82	China
Mg2-2a	Gx			1 137	9.81-10.18-10.17	U.S.S.R.
Mg2-2ab	Gx			5 892	10.18-9.73-9.34-10.17	U.S.S.R.
Mg3-2ab	Gx Od			600	9.34-10.19	U.S.S.R.
Mg4-3a	Gx C		Phreatic	328	10.18	U.S.S.R.
Mg5-2ab	Dg Gx	De Gh		1 865	9.34	U.S.S.R.
Mo1-2a				1 433	9.32-9.33	U.S.S.R.
Mo1-2ab				3 516	8.32-9.31	U.S.S.R.
Mo1-3a				2 036	9.32-9.34	U.S.S.R.
Od1-a				7 114	10.57-9.81	China
Od1-a				56 999	8.32-9.81-10.18-10.19-10.17-10.12-10.25-10.22	U.S.S.R.
Od15-a	Bg			2 537	10.12-10.18	U.S.S.R.
Oe1-a				136	10.12	Dem. People's Rep. of Korea
Oe1-a				29 707	8.32-7.71-8.26-10.12-8.33-9.81-10.17-10.19-9.32-10.24-10.22-10.27	U.S.S.R.
Oe1-3a				660	3.72	U.S.S.R.
Oe5-3a	Zg			209	9.72	U.S.S.R.
Oe5-3a	Zg		Saline	397	3.72	U.S.S.R.

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Oe6-3a	Ge	Zg	Saline	313	3.72	U.S.S.R.
Oe8-a	Jc			310	10.12	U.S.S.R.
Pg3-1ab		Gd		5 522	10.17	U.S.S.R.
Ph9-1ab		Gd Gh		13 991	10.17-9.34-8.32	U.S.S.R.
Qc47-1a	Rc	Yk Z		2 209	3.71	U.S.S.R.
Rd1-1b				1 227	9.31-9.32-9.34	U.S.S.R.
Rx1-b			Lithic/rock debris	5 176	10.3	U.S.S.R.
S2-3a	Z			3 806	3.72-9.72	U.S.S.R.
Sg2-3a	Zg		Saline	191	3.72	U.S.S.R.
Sg3-3a	So			281	9.72	U.S.S.R.
Sg4-2a	Ge			155	9.72	U.S.S.R.
Sg5-a	So	Ge Je	Shifting sand	54	9.72	U.S.S.R.
Sg5-2a	So	Ge Je		370	3.72-9.72	U.S.S.R.
Sm12-3a	Sg			6 388	9.33-9.32	U.S.S.R.
Sm13-3a	Sg	Ge Je		4 454	9.33-9.32-9.34	U.S.S.R.
Sm14-3a	Zg Zm			388	9.33-9.32	U.S.S.R.
So1-3a	Zo			1 672	3.71-3.72-9.72-9.33	U.S.S.R.
So3-3a	Kl			119	9.72	U.S.S.R.
So16-2a				1 113	3.71-3.72-9.72-9.33	U.S.S.R.
So16-2a			Lithic	3 698	9.72	U.S.S.R.
So16-3a				6 137	9.72-3.71-3.72-9.33	U.S.S.R.
So18-2a	Sg	Zg		463	3.72	U.S.S.R.
So19-2a	Sg Zg	Zo		773	9.72	U.S.S.R.
Th19-2bc	R	Ao		132	—	Rep. of Korea
To10-b	Tv			2 797	10.12-10.17	U.S.S.R.
To11-b	P	Tv		2 678	10.17-10.25-10.12	U.S.S.R.
To12-ab	Od P	Tv		1 839	10.17-10.25	U.S.S.R.
To13-2/3b	Ao Bd	Af		72	7.51	Japan
To14-2b	Bd Tv	I Re		741	8.12-7.61	Japan
To15-2/3b	Ao Tm Tv			492	8.11	Japan
To16-2/3b	Tm	Tv		4 940	1.61-8.11-8.12-7.61-8.23-8.21-7.62	Japan
To17-2b	Tv	Re		132	7.61-7.62	Japan
Tv30-a	Od	G Th To		1 878	10.17-10.25-10.12	U.S.S.R.
Tv31-ab	Th To	Gh		406	10.17	U.S.S.R.
Tv32-2b	Th	I Re	Lithic	423	7.71-7.62-8.23	Japan
Vp66-3a	Gm			11 797	2.32-2.25-8.15-8.11-4.12	China
We20-3a	Ge Oe	Gm Lg		2 035	8.32-8.26-10.12	China
Ws14-3a	Ge	Sg		307	9.32-9.34	U.S.S.R.
X1-2a				4 322	9.89-3.73	China
Xh2-1b				390	10.54	China

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Xh2-1b				704	6.75-9.72	U.S.S.R.
Xh2-2a				290	6.78	U.S.S.R.
Xh2-2b				2 143	9.72-6.78-3.72-9.33	U.S.S.R.
Xh2-2b			Lithic	728	3.72-6.78	U.S.S.R.
Xh2-2b			Stony	815	3.72-3.71	U.S.S.R.
Xh49-2ab	X1	Zo		668	3.72	China
Xk4-1b				299	3.71	U.S.S.R.
Xk4-1b			Rock debris	1 093	3.71	U.S.S.R.
Xk4-1b			Stony	2 776	3.71-6.78	U.S.S.R.
Xk4-1b			Lithic/stony	125	3.71	U.S.S.R.
Xk4-2ab				5 851	3.71-6.79-6.78	U.S.S.R.
Xk4-2b				2 245	10.54-3.72-6.78-3.71	U.S.S.R.
Xk4-2b			Lithic	1 209	3.71	U.S.S.R.
Xk4-2b			Lithic/stony	1 218	3.71	U.S.S.R.
Xk37-2ab	Zo		Saline	7 092	3.72-9.89	China
Xk37-2b	Zo			567	3.71-6.91	U.S.S.R.
Xl1-1ab	I		Sodic	2 588	3.72-9.72	U.S.S.R.
Xl1-2b	I		Sodic	463	3.71-3.72	U.S.S.R.
Xl1-3b	I		Sodic	218	3.72	U.S.S.R.
Xl16-1ab			Sodic	1 051	3.72-9.72	U.S.S.R.
Xl16-2a			Sodic	144	3.72	China
Xl16-2a			Sodic	2 609	9.72-3.72	U.S.S.R.
Xl16-2b				2 201	9.72-3.72-9.73	China
Xl16-2b				4 614	10.57-3.73	Mongolia
Xl16-2b				657	10.53-6.75-9.72	U.S.S.R.
Xl16-2b			Sodic	531	3.72-3.71	U.S.S.R.
Xl16-2b			Sodic/lithic	251	3.71	U.S.S.R.
Xl17-1a	So Zo		Sodic	1 236	3.72	U.S.S.R.
Xl17-2a	So Zo		Sodic	5 385	3.72-9.72	U.S.S.R.
Xl18-2ab	So Zo	Zt	Sodic	3 801	3.72-9.72	U.S.S.R.
Xl 18-2b	So Zo	Zt	Sodic	2 000	3.72-9.72	U.S.S.R.
Xl19-2b	Xy	Z	Stony	4 836	3.72-9.72	U.S.S.R.
Xl20-2b	Zo			21 986	10.57-3.73-3.72	Mongolia
Xl20-2b	Zo			9 390	3.72	China
Xl21-1ab	So		Sodic	239	9.72	U.S.S.R.
Xl21-1b	So		Sodic	340	3.71	U.S.S.R.
Xl22-1/2a	Z		Sodic	821	3.72-9.72	U.S.S.R.
Xl23-2ab	Gm So		Sodic/lithic	2 101	3.72	U.S.S.R.
Y1-1b				621	3.72-3.71	China
Y1-2a			Phreatic	213	9.72	China
Y1-2b				6 912	3.71-3.72	China
Y6-2a	Z		Phreatic	1 836	3.71-3.73	China
Y14-1a		Z		1 030	3.71	U.S.S.R.
Yh2-1b	Zo			149	9.33	U.S.S.R.
Yh2-2b	Zo			7 905	3.73-3.72	Mongolia

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*continued*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Yh11-1b				433	9.72	China
Yh11-1b			Stony	105	10.54	China
Yh11-1b			Stony	143	9.72	U.S.S.R.
Yh11-2ab				4 705	3.72	Mongolia
Yh11-2ab				8 658	3.72-9.73	China
Yh11-2ab				522	9.33-9.72	U.S.S.R.
Yh11-2b				5 300	9.72-3.73	China
Yh11-2b				522	9.33-9.72-10.54	U.S.S.R.
Yh11-2b			Lithic	1 648	3.72	U.S.S.R.
Yh11-2b			Lithic/stony	839	3.72	U.S.S.R.
Yh23-2ab	Rc Yk	Zo		2 687	6.78	U.S.S.R.
Yh26-2b		Zo		1 652	10.57-3.72	China
Yh26-2b		Zo	Stony	11 781	3.72	Mongolia
Yh26-2b		Zo	Stony	4 307	3.72	China
Yh28-2b	So Yy	Gc Z	Stony	4 615	3.72-9.72	U.S.S.R.
Yh29-2a	So			328	3.72	U.S.S.R.
Yh29-2b	So		Lithic	597	3.72	U.S.S.R.
Yh30-2b		Gc	Lithic	457	3.72	U.S.S.R.
Yh31-2a	Gc			1 010	3.72	China
Yh41-2ab	Xh	Zo Je		108	3.72	China
Yk1-1b				379	3.71-3.72	U.S.S.R.
Yk1-1b			Shifting sand	863	3.71	U.S.S.R.
Yk1-2a				224	6.79-3.72-3.71	U.S.S.R.
Yk1-2b				1 325	3.71	U.S.S.R.
Yk1-2b			Stony	1 370	3.71	U.S.S.R.
Yk1-3a			Saline	173	3.71	U.S.S.R.
Yk37-1b	Zo	I	Lithic	2 039	3.71	U.S.S.R.
Yk37-2a	Zo	I		69	3.71	U.S.S.R.
Yk37-2a	Zo	I	Stony/salt flats	1 015	3.71	U.S.S.R.
Yk37-2ab	Zo	I		527	10.57-3.73	China
Yk38-3a	Rc Yh	Zo	Stony	36	6.78	U.S.S.R.
Yk43-2b	So Zo	I Yy		78	3.71	U.S.S.R.
Yk43-3ab	So Zo	I Yy	Salt flats	19 647	3.72-3.71	U.S.S.R.
Yk44-2b	So Yy	Gc Zo		185	3.71	U.S.S.R.
Yk44-3a	So Yy	Gc Zo		3 454	3.71	U.S.S.R.
Yk45-2b		Gc	Lithic	1 015	3.71	U.S.S.R.
Yk46-2b	Gc			382	3.71	U.S.S.R.
Yk47-3a	Sg			203	3.72	U.S.S.R.
Yt1-1b				137	3.71	U.S.S.R.
Yt1-2b				507	3.71	U.S.S.R.
Yt1-3a				269	3.71	U.S.S.R.
Yt3-2a		Zo		427	6.72-3.72	U.S.S.R.
Yt3-2b		Zo		42	3.72	U.S.S.R.
Yt3-2b		Zo	Stony	75	9.33	U.S.S.R.
Yt3-3a		Zo		1 634	3.71	China
Yt3-3a		Zo		5 976	3.72-3.71	U.S.S.R.

TABLE 4. – SOIL ASSOCIATIONS AND RELATED INFORMATION (*concluded*)

Map symbol	Associated soils	Inclusions	Phase	Extension (1 000 ha)	Climate	Occurrence
Yt4-2a	Zo	Zt		819	3.71	China
Yt4-3a	Zo	Zt		581	3.71	China
Yt4-3a	Zo	Zt		791	3.71	U.S.S.R.
Yt5-3a	Zt			203	3.71	U.S.S.R.
Yt6-3a		Zo Zt		1 764	3.72-3.71	U.S.S.R.
Yt7-1b	Zo			704	3.71	U.S.S.R.
Yt8-3a		Gc		3 478	3.71	China
Yy14-a	Zo		Petrogypsic	87	3.72	Mongolia
Yy14-a	Zo		Petrogypsic	16 407	3.72-3.73	China
Z1-2a				3 728	3.73-9.81-9.89-3.72	Mongolia
Z1-2a				1 501	3.71-3.72-3.73	China
Z1-2a				495	3.72-3.71	U.S.S.R.
Z1-3a				2 388	3.73	China
Z1-3a				3 531	3.72-9.72-3.71	U.S.S.R.
Zg3-3a	Zo		Salt flats	421	3.71	U.S.S.R.
Zg6-3a				426	3.72-3.71	China
Zg6-3a				1 254	9.72-3.71-3.72	U.S.S.R.
Zg16-2/3a	Gm Zm	Jt		2 439	1.23-8.16-9.11-9.87-8.26	China
Zg17-2/3a	Zm			4 199	3.71-3.72	China
Zm2-2/3a	Gm Sm			85	9.89	Mongolia
Zm2-2/3a	Gm Sm			6 349	9.81-9.89-3.72-9.82-8.26	China
Zo7-2a	Zg		Lithic	1 069	3.72	U.S.S.R.
Zo16-3a	Zg Zt		Salt flats	2 719	3.71-3.72	U.S.S.R.
Zo26-3a	Zt Zg	Ge		1 717	3.72-3.73	China
Zo26-3a	Zg Zt	Gc		576	3.71	U.S.S.R.
Zo34-3a	Zg Zt	Gc		155	3.72	U.S.S.R.
Zo37-a	Y			10 913	3.71-3.72	China
Zt1-3a				496	3.71	U.S.S.R.
Zt2-3a	Zo			1 728	3.72	China
Zt2-3a	Zo			415	3.71	U.S.S.R.
Zt3-3a		Zo		209	3.71-6.91	U.S.S.R.
Zt4-3a	Zg			90	3.71	U.S.S.R.
Shifting sand				380 82 39 423 46 808		Mongolia Japan China U.S.S.R.
Ice caps				14 138 2 361		China U.S.S.R.
Rock debris/shifting sand				6 418		U.S.S.R.

arctic wastes are not arable and can maintain only limited herds of reindeer.

Arctic tundra occurs in a narrow belt along the north coast of the continent. There are numerous lakes as well as mainly eutrophic-type swamps with *Hypnum* mosses and herbaceous vegetation. The cryogenic microrelief formed by polygons, stony rings, wide cracks and hummocks is more pronounced here. Gelic Gleysols are the dominant soils. All kinds of thixotropic phenomena occur owing to the excessive moisture and permafrost. The natural vegetation (chiefly mosses) is more developed and covers the surface almost completely. Annual production of green plant mass is about 700 kg/ha. Summer grazing for reindeer is the only land use of the area. Cultivation is impossible on open ground.

A2. Subarctic zone of Gelic Gleysols

This tundra zone lies south of Zone *A1*. Excessive water saturation and permafrost produce permanent anaerobic conditions in the solum which result in pronounced gleyification. Terraced and glacial plains composed of loose sediments (sands, loams, clays, often with boulders and pebbles) are the landform here. Because of the permafrost, lakes, swamps and hummocky and polygonal microrelief are common. In the northern part of the tundra the surface is mostly covered by mosses, lichens and herbs, whereas in the south there are also shrubs and dwarf trees. Eutrophic and oligotrophic peat swamps occupy large areas. Annual production of green plant mass is about 1.2 t/ha. Reindeer grazing is the main land use; agriculture on open ground is possible only in the southern part of the tundra, where some vegetables, potatoes and grasses can be grown on a limited scale. The dominant Gelic Gleysols occur with various Histosols. Fluvisols occur in river valleys, especially in the deltas of the major rivers. Two plains soil regions are differentiated within the zone.

The Chukchi-Anadyr region (*A2.2*) has a relatively humid climate and hummocky herbaceous tundra in association with herbaceous eutrophic *Hypnum* swamps. Broad belts of dwarf shrubs and open forest occur in places. Gelic Cambisols sometimes appear as inclusions in a soil association of Gelic Gleysols, Eutric Histosols and Gelic Histosols.

The northern Siberian region (*A2.4*) occupies the largest portion of the zone and is characterized by moss-lichen tundra. Shrubs and open forest occur mostly in the river valleys. The climate is more continental and generally less humid. Spotty (mosaic) tundra represents the main soil pattern. Eutric Histosols and Dystric Histosols occur among the main cover of Gelic Gleysols. Calcareous soils are also common. Gleyification of soils is generally not as strong as in region *A2.2*. There is permafrost even in the river flood plains.

a. Mountain soil regions

The northern Ural mountain soil region (*a.1*) includes the polar ranges of the Urals, which have altitudes ranging from 500 to 1 000 metres in the north to 1 000 to 1 500 metres in the south. The central Urals have alpine landforms with deep gorges and steep escarpments. Signs of recent glaciation (e.g. moraines, trough valleys and glacial lakes) are prominent. The eastern and central parts of the region are composed of metamorphic rocks with acid to ultrabasic intrusions. The western part is composed of Paleozoic limestones, clay shales and sandstones. Lithosols predominate in association with Gelic Gleysols and Gelic Regosols of lithic phase. The altitudinal soil zonality is not marked. Lithosols and Gelic Regosols are common at higher elevations, while Gelic Gleysols occur at lower levels. Podzols sometimes occur in foothills.

The Chukchi soil region (*a.2*) is an extreme example of a humid maritime environment. The mountains have altitudes ranging from 1 500 to 2 000 metres, and some peaks are much higher. Mesozoic shales and sandstones intruded with acid and basic igneous rocks form the lithological pattern. The climate varies with slope orientation and altitude, but is always extremely cold. Scrub tundra occurs up to an elevation of about 200 metres, and above this only lichens and some dwarf plants can survive. The soil cover comprises Lithosols and Gelic Regosols with a few Gelic Gleysols. This region has not been thoroughly studied.

The Taimyr soil region (*a.3*), comprising the Byrranga massif in the Taimyr Peninsula, represents the extreme northern variant of montane tundra above 75°N. The altitude generally ranges from about 500 to 1 000 metres, with some peaks reaching 1 500 metres. Rock outcrops and Lithosols occupy the largest areas, and small patches of Gelic Regosols and Gleysols are found in depressions. Polar waste landscapes are common.

SOIL REGIONS OF THE BOREAL COLD TEMPERATE BELT

C. *Central taiga province*

This large province occupies the largest portion of the vast western Siberian lowland of the Ob river basin, which is characterized by poor drainage. The area is almost completely covered by coniferous forest with many oligotrophic swamps. There are two soil zones in the province: the larger northern one, subdivided into three subzones, has coniferous taiga with Podzols and Podzoluvisols, and the southern one has leaved forest with Greyzems.

C1. Northern taiga subzone of Gleyic Podzoluvisols and Gleyic Podzols

This subzone borders the tundra from the south and is a transition to taiga proper. Forest-tundra scrub and open swampy ground are common.

TABLE 5. – SOIL REGIONS OF NORTH AND CENTRAL ASIA

Soil-bioclimatic belts	Soil-bioclimatic provinces	Soil zones or subzones	Soil regions: Plains	Soil regions: Mountains
Polar belt	A. Eurasian polar province	A1. Arctic zone of Gelic Gleysols and Gelic Regosols		a.1 Northern Urals a.2 Chukchi a.3 Taimyr
		A2. Subarctic zone of Gelic Gleysols	A2.2 Chukchi-Anadyr A2.4 Northern Siberia	
Boreal cold temperate belt	C. Central taiga province	C1. Northern taiga subzone of Gleyic Podzoluvisols and Gleyic Podzols	C1.4 Western Siberia	c.2 Urals
		C2. Central taiga subzone of Dystric Podzoluvisols	C2.4 Western Siberia C2.5 Angara	
		C3. Southern taiga subzone of Eutric Podzoluvisols	C3.5 Western Siberia C3.6 Angara	
		C4. Forest zone of Greyzems	C4.4 Western Siberia C4.5 Pre-Altai	
	D. Eastern Siberian cryogenic taiga province	D1. Northern taiga subzone of Gelic Cambisols and Gelic Gleysols	D1.1 Northern Lena D1.2 Yana-Kolyma	d.1 Kolyma d.2 Upper Amur d.3 Transbaikalia d.4 Aldan d.5 Northern Baikal d.6 Eastern Sayan d.7 Yenisei d.8 Putorana d.9 Upper Yana
		D2. Central taiga subzone of Gelic Cambisols	D2.1 Central Siberia D2.2 Central Yakutia	
		D3. Southern taiga subzone of Gleyic Cambisols and Dystric Cambisols	D3.1 Upper Zeya	
		D4. Forest zone of Dystric Regosols and Podzoluvisols	D4.1 Transbaikalia	
	E. Far Eastern taiga meadow-forest province	E1. Meadow-forest zone of Andosols	E1.1 Eastern Kamchatka E1.2 Western Kamchatka E1.3 Central Kamchatka	e.1 Kamchatka e.2 Okhotsk e.3 Sikhote Alin-Sakhalin
		E2. Taiga forest zone of Dystric Podzoluvisols	E2.1 Magadan E2.2 Amur-northern Sakhalin	
Subboreal temperate belt	G. Central forest-steppe and steppe province	G1. Forest-steppe zone of Greyzems and Luvic Chernozems	G1.4 Western Siberia G1.5 Pre-Altai G1.6 Western pre-Sayan G1.7 Eastern pre-Sayan G1.8 Northern Manchuria	g.1 Southern Urals g.2 Southern Altai g.3 Altai-Sayan g.4 Khangai g.5 Greater Khingan
		G2. Steppe zone of Haplic Chernozems and Calcic Chernozems	G2.6 Kazakhstan G2.7 Pre-Altai G2.8 Minusinsk G2.9 Transbaikalia G2.10 Southern Manchuria	
		G3. Dry steppe zone of Haplic Kastanozems	G3.3 Trans-Volga G3.4 Kazakhstan G3.5 Tuva G3.6 Transbaikalia-Manchuria	
	H. Eastern forest province	H1. Coniferous broadleaf forest zone of Cambisols and Luvisols	H1.1 Ussuri-Khanka H1.2 Zeya-Bureya	h.1 Southern Sikhote Alin h.2 Lesser Khingan-northern Korea h.3 Northern Japan

TABLE 5. - SOIL REGIONS OF NORTH AND CENTRAL ASIA *(concluded)*

Soil-bioclimatic belts	Soil-bioclimatic provinces	Soil zones or subzones	Soil regions: Plains	Soil regions: Mountains
	I. Desert steppe and desert province	I1. Desert steppe zone of Luvic Kastanozems and Luvic Xerosols	I1.1 Caspian I1.2 Kazakhstan I1.3 Zaysan I1.4 Eastern Altai I1.5 Eastern Mongolia I1.6 Central China	i.2 Saur-Tarbatagay i.3 Northern Tien Shan i.4 Southern Tien Shan i.5 Eastern Tien Shan i.6 Kunlun i.7 Northern Himalayas i.8 Eastern Tibet i.9 Nan Shan
		I2. Desert zone of Haplic Yermosols and Calcic Yermosols	I2.1 Aral-Caspian I2.2 Aral-Balkhash I2.3 Dzungaria I2.4 Tarim I2.5 Takla Makan I2.6 Turfan-Ka-shun I2.7 Gobi I2.8 Tsaidam	
		I3. Piedmont desert steppe zone of Haplic Xerosols	I3.1 Northern Tien Shan	
	J. High-mountain desert province			j.1 Central Tien Shan j.2 Karakoram j.3 Tibet
Subtropical warm temperate belt	K. Subtropical humid forest province	K1. Humid forest zone of Orthic Acrisols and Ferric Acrisols	K1.2 Chungking K1.3 Southern China K1.4 Western Taiwan K1.5 Lower Yangtze	k.3 Southern Himalayas k.4 Eastern Himalayas k.5 Southern Korea k.6 Southern Japan k.7 Tapieh k.8 Upper Yangtze k.9 Shan plateau k.10 Nan Ling k.11 Southern China k.12 Bohea k.13 Eastern Taiwan
		K2. Humid forest zone of Ferric Luvisols and Orthic Acrisols	K2.1 Annam-Tonkin	
	L. Subtropical xerophytic forest province	L1. Xerophytic forest zone of Chromic Cambisols and Calcic Cambisols	L1.2 Ch'in Ling L1.3 Shantung L1.4 Northern China	
	M. Subtropical desert steppe and desert province	M1. Desert zone of Calcic Yermosols and Takyric Yermosols	M1.1 Northern Turan M1.2 Southern Turan	m.1 Western Tien Shan m.2 Badakhshan-Gissar m.3 Kopet Dag
		M2. Piedmont desert steppe zone of Calcic Xerosols	M2.2 Western Tien Shan M2.3 Pre-Gissar M2.4 Pre-Kopet Dag	

The subzone includes the western Siberian soil region of Gleyic Podzoluvisols and Gleyic Podzols (*C1.4*). The main feature of the soil pattern is surface gleying of the soils, which is probably the result of a rainfall which exceeds evapotranspiration, and drainage conditions which are poor despite the predominantly light texture of surface deposits. The lowland is mostly flat, with altitudes of watersheds ranging from 10 metres in the north to 150 to 200 metres in the south. East of the Ob river altitudes never exceed 100 metres. The surface material is of fluvioglacial origin and is represented mostly by sands, which are often gravelly and contain boulders. The permafrost here is relict, and appears below a depth of about 40 to 100 metres in Quaternary deposits. Narrow areas along river valleys are usually better drained. Gleyic Podzoluvisols are the dominant soils, but Humic Podzols, Gleyic Podzols, Dystric Cambisols and Gleyic Cambisols also occur. All soils have a predominantly coarse texture. Dystric Histosols predominate in swamps. Agriculture is of little importance in the region, and is concentrated along river valleys.

C2. *Central taiga subzone of Dystric Podzoluvisols*

This subzone has a continuous cover of coniferous forest and is better drained than the northern one, but oligotrophic swamps are still common. It includes two plains soil regions:

In the western Siberian region of Dystric Podzoluvisols (*C2.4*), Dystric Histosols occur widely. The region has a more or less flat relief broken in places by rolling to hilly watersheds. Numerous lakes (probably of thermo-karst nature) complicate the surface pattern. Quaternary loose sediments, mostly of medium texture, are the predominating parent materials. The better-drained areas are occupied by Dystric Podzoluvisols, whereas the poorly drained lowlands have Gleyic Podzoluvisols and Histosols. Forestry is of primary economic importance; agricultural activity is limited and concentrated along river valleys.

The Angara region of Dystric Podzoluvisols (*C2.5*) has better drainage conditions and fewer swamps and lakes. It is an upland of the Angara river basin with altitudes of several hundred metres. The parent materials are mostly detritus from weathered basaltic traps, and are often calcareous.

C3. *Southern taiga subzone of Eutric Podzoluvisols*

This subzone is relatively warmer than the previous one. The forest is more open and has a grassy ground cover. Birch and poplar forests often occur among the predominant coniferous forests. The Eutric Podzoluvisols often have an accumulation of organic matter in the B horizon which is believed to be a remnant of previous stages of soil formation. The subzone has two plains soil regions:

The western Siberian region of Eutric Podzoluvisols (*C3.5*) has many soils with an accumulation of organic matter in the B horizon. Greyzems occupy ancient river valleys. It is a swampy lowland lying at 120 to 150 metres, and is poorly drained. Near the Ural ranges and in the area east of the Ob river the topography is more undulating, with altitudes ranging from 200 to 300 metres and better drainage conditions in river valleys. The region is composed of Quaternary sediments overlain by loess-like loams containing calcium carbonate at depths of 2 to 3 metres. Swamps are numerous; most are of the oligotrophic type, but eutrophic swamps also occur frequently. The Eutric Podzoluvisols are extremely rich in humus (up to 6 percent in arable land and up to 9 percent under forest). No more than 7 percent of the region is utilized for agriculture, most of which is practised in the better-drained areas.

The Angara region of Eutric Podzoluvisols (*C3.6*) occupies the foothills of the Angara river basin where altitudes range from 300 to 600 metres in the east to 800 to 900 metres in the west. It is more continental and better drained. Most of the parent materials have been produced by weathering of basaltic traps and hard sedimentary rocks, most of which are calcareous.

C4. *Forest zone of Greyzems*

This zone stretches in a narrow belt from west to east through all of western Siberia south of the coniferous forest zone. It is characterized by the sporadic occurrence of pine-birch-poplar mixed forest, and has two plains soil regions:

The western Siberian region (*C4.4*) has Greyzems which are mostly gleyed and solodized to varying degrees. Phreatic Chernozems, also often solodized, are common. It is a poorly drained lowland with altitudes of 100 to 150 metres, and is composed of a series of Quaternary fluviatile deposits overlain by loess-like loams and clays. Solonetz occur in the southern part of the region, and Solodic Planosols are also common.

The pre-Altai region of Greyzems (*C4.5*) has altitudes of 200 to 400 metres in the east and west and 150 to 200 metres in the central part. The drainage conditions vary accordingly, being rather poor in the central part. Paleozoic and Mesozoic rocks, overlain by Quaternary deposits, outcrop in the river valleys. Loess-like loams, mostly calcareous, are the most common parent materials. The soil cover comprises chiefly Greyzems, which are aften gleyed to varying degrees. The soils often have an accumulation of organic matter in the B horizon. Luvic Chernozems also occur near river valleys.

c. *Mountain soil region*

The Ural region (*c.2*) includes the largest portion of the Ural ranges and lies approximately between the latitudes 56° and 66°N. The mountain ranges are separated by narrow synclinal valleys. The highest mountains (1 500 to 1 800 metres) are in the northern part of the region. The western slope of the range is composed of sedimentary rocks (sandstones, marls, shales, dolomites) and the central part consists of metamorphic mica and chlorite schists and some quartzite and silicious limestone. Beds of Paleozoic sedimentary rocks are intruded with acid and basic rocks. The region is almost completely covered by coniferous forest. Lithosols predominate, and Dystric Podzoluvisols of lithic phase are the associated soils. Gelic Gleysols and Gelic Regosols are covered by montane tundra in the northern ranges, and by montane meadow in the high areas of the southern ranges.

D. *Eastern Siberian cryogenic taiga province*

The vast cryogenic taiga province occupies the mountains and uplands of Siberia east of the Yenisei river. Permafrost is a major soil feature of the area, occurring everywhere in the north and in patches in the south. A province of continuous Siberian-type forest, it is characterized by a specific soil pattern. It may be divided into two main soil zones which in general correspond to the zones of the western Siberian lowland and comprise several soil regions.

D1. Northern taiga subzone of Gelic Cambisols and Gelic Gleysols

This subzone occupies the lowlands of the Lena, Yana, Indigirka and Kolyma rivers north of the Arctic circle, where altitudes range from 50 to 100 metres. The lowlands, composed of loose Quaternary sediments, are poorly drained and contain numerous lakes and swamps. Gelic Cambisols cover the area, and are associated mostly with Gelic Gleysols. Gelic Regosols are also common. Fluvisols and Gleysols characterize the river flood plains. Gleyification is widespread.

There are two plains soil regions in this subzone: the northern Lena region (*D1.1*), where Gelic Cambisols are mostly associated with Dystric Histosols, and the Yana-Kolyma region (*D1.2*), where Gelic Cambisols are mostly associated with Eutric Histosols.

D2. Central taiga subzone of Gelic Cambisols

This subzone lies to the south of subzone *D1*, approximately between 60° and 65°N. On the west it traverses the central Siberian plateau, which is composed of sedimentary rocks and basaltic traps and is deeply dissected by several river systems, and on the east the central Yakutian depression, composed of sedimentary rocks overlain by Quaternary deposits. It has a typical Siberian-type larch taiga with moss ground cover. The subzone has two plains soil regions:

The central Siberian region of Gelic Cambisols (*D2.1*) occupies the western part of the subzone where altitudes range from 200 to 900 metres. The plateau is composed of clay shales, sandstones, limestones, dolomites and basaltic traps overlain by a thin eluvium. Larch and pine taiga covers the entire region with the exception of the river valleys, where there are some meadows and swamps. The soils are usually very acid and have permafrost at 40 to 150 cm below the surface, depending on the texture, lithology and position on the slope.

The central Yakutian soil region (*D2.2*) is peculiar in many respects. It is especially well known on account of the wide occurrence of Solodic Planosols and Solonetz so far away from their main steppe environment. In the peripheral part of the region, a plain transected by river valleys, altitudes range from 270 to 450 metres. Cretaceous and Jurassic hard rocks here are overlain by a thin eluvium which serves as a parent material. An ancient alluvial plain, with altitudes of 100 to 270 metres, comprises the main part of the region. Recent river terraces complete the landform pattern. In the summer permafrost is always found at more than 150 cm below the surface. The soil cover of the region is rather complicated. Among the dominant Gelic Cambisols, which are mostly saturated and often contain some exchangeable sodium, there are Solodic Planosols and Gleyic Solonetz. Soil associations always include Calcic Cambisols. Various meadow soils are often solodized and solonetzic.

D3. Southern taiga subzone of Gleyic Cambisols and Dystric Cambisols

This subzone is represented by the upper Zeya soil region (*D3.1*) of Gleyic Cambisols, which are mostly associated with Dystric Cambisols under a cover of birch-larch forest. It includes the Amur-Zeya plateau, the foothills of several mountain ranges, and the upper Zeya plain. Medium-to-coarse-textured loose Quaternary deposits overlie the hard rocks of the crystalline basement. River valleys are usually swampy. The soils are generally very acid.

D4. Forest zone of Dystric Regosols and Podzoluvisols

This zone is represented by the Transbaikalian plains soil region (*D4.1*), which is rather complex and consists of two isolated massifs which separate the steppe zone in the south from the northern mountain ranges. Mountain ranges 900 to 1 300 metres high alternate with deep, wide intermontane depressions. The mountain ranges, covered by larch forest, are characterized by the association of Lithosols with Dystric Regosols and Dystric Podzoluvisols, and phreatic Chernozems predominate in the intermontane depressions. These Chernozems contain up to

6 percent of humus. The thickness of the humus horizon is about 30 to 50 cm, and the accumulation of about 80 percent of the total humus reserve in the upper 20-cm layer of the soil is a specific feature of the region.

d. Mountain soil regions

The eastern Siberian mountain systems are so different and so widely separated that they must be grouped into several soil regions, each with its own soil pattern and environmental conditions. There are nine broad mountain soil regions:

The Kolyma soil region (*d.1*) lying in the northeastern part of the province comprises the Kolyma range and adjoining mountain chains, and the Yukagyr plateau. Sedimentary hard rocks are the main parent materials. Gelic Cambisols and Dystric Podzoluvisols cover the foothills, and tundra landscapes with Gelic Gleysols and Gelic Regosols occur at higher elevations. Lithosols occur widely on both the lower and higher slopes.

The Upper Amur soil region (*d.2*) occupies the mountain ranges of the upper Amur and Buieya basins, and is composed mostly of granites, gneisses and metamorphic schists. Lithosol dominants and Dystric Podzoluvisols are the most important soils in this thickly forested area.

The Transbaikalian mountain soil region (*d.*3) comprises several ranges with altitudes ranging from 1 000 to 1 500 metres. Granites are the main parent rocks, and crystalline schists, dacites, basalts and other related rocks are common. Lithosols are mostly associated with Dystric Podzoluvisols, Dystric Cambisols and Gelic Cambisols; all are of lithic phase. Tundra landscapes with Gelic Gleysols and Regosols replace the forest landscape at elevations above 1 400 to 1 900 metres.

The Aldan soil region (*d.4*) includes the northern slope of the Stanovoy range and some adjoining mountain ranges. Crystalline acid metamorphic rocks are the main parent materials, and there are also calcareous rocks. Lithosols predominate in the area, and occur with Dystric Podzoluvisols and Calcaric Regosols in the foothills. Histosols and various Gleysols are common in the valleys, and an I-Gx-Rx association occurs at elevations above 1 100 to 1 200 metres.

The northern Baikal soil region (*d.5*) includes a great number of mountain ranges around the northern portion of Lake Baikal with altitudes up to 2 000 to 3 000 metres. Some mountains have rough alpine landforms and others have soft rounded surfaces. A number of depressions separate the ranges. Granites, gneisses and basalts are the main hard rocks, and loose sediments derived from them occur in the depressions. Lithosols are dominant on mountain slopes. They are associated with Gelic Cambisols and Calcaric Regosols in the western part of the region, with Dystric Podzoluvisols in the centre, and with Dystric Cambisols and Podzoluvisols and Gelic Cambisols in the east. The region has a thick larch taiga forest. Tundra landscapes with Gelic Gleysols and Gelic Regosols associated with the dominant Lithosols are prominent at higher elevations.

The eastern Sayan soil region (*d.6*) includes the Sayan ranges west of Lake Baikal. The mountains are formed by hard rocks (gneisses, amphibolites, micaschists, limestones, quartzites), and granitic intrusives and basaltic extrusives are common. Loose debris from these weathered rocks are found in intermontane depressions. The complex soil cover consists of various Lithosol-dominated soil associations. Dystric Podzoluvisols are the main associated soils, and Gelic Cambisols, Gelic Gleysols, Gelic Regosols and Dystric Regosols are also common. The mountain slopes are covered by birch-pine taiga forest, and tundra occurs at higher elevations.

The Yenisei soil region (*d.7*) includes the southern part of the mountains east of the Yenisei river. Altitudes range from 300 to 1 100 metres. It is a deeply dissected low montane plateau with softly rounded relief formed by folded and strongly metamorphosed ancient sedimentary hard rocks, including clay shales, limestones and sandstones. Dystric Podzoluvisols occupy the foothills and lower elevations, while Lithosols, Gelic Cambisols and Dystric Regosols are the main soils on mountain slopes. Patches of tundra may occur on mountain tops.

The Putorana soil region (*d.8*) includes the northern mountain system east of the Yenisei river with altitudes up to 2 000 metres. It is a plateau-like mountain system formed mainly by Paleozoic limestones, dolomites, sandstones and clay shales; diabase traps are common in the southern part. Tundra is characteristic above 700 to 800 metres, while open larch forest of the northern taiga type and large areas of forest tundra occur at lower elevations. Gelic Cambisols and Gelic Gleysols are associated with Lithosols.

The upper Yana soil region (*d.9*) represents the extreme continental montane environment of the province. It includes the Verkhoyansk and Cherski ranges with altitudes up to 2 500 to 3 000 metres in the south and 500 to 1 000 metres in the north. The mountains consist mainly of non-calcareous sedimentary folded rocks with some acid intrusives and Mesozoic effusives. Tundra ladscapes are the main feature above 600 to 800 metres in the north and 1 200 to 1 300 metres in the south, while lower elevations are characterized by open larch taiga forest. A specific feature of the region is the mosaic of steppe landscapes on some southern slopes of the ranges. Two soils associations, I-Bx-Dd and I-Gx-Rx, predominate in the region.

E. *Far Eastern taiga meadow-forest province*

This province occupies relatively small areas along the coast of the Far East region of the U.S.S.R. As it is influenced by the Pacific Ocean, its environment differs greatly from that of the rest of eastern Siberia. The province may be divided into the meadow-forest zone of Andosols and the taiga forest zone of Dystric Podzoluvisols.

E1. Meadow-forest zone of Andosols

This zone is a specific feature of the Kamchatka Peninsula with its volcanic environment, and of the northern Kuril islands. As it is subject to vigorous, ongoing volcanism, Andosols are the main soils. The zone has three plains soil regions:

The eastern Kamchatka soil region (*E1.1*) includes the eastern coastal plains of the peninsula, formed by a thickness of volcanic ash. Ochric Andosols and Vitric Andosols are the dominant soils. Dystric Histosols and Gleysols characterize swampy terrain and Humic Andosols occur in poorly drained areas. The soils are acid and clearly stratified.

The western Kamchatka soil region (*E1.2*) occupies the western coastal plain. The influence of volcanic activity is less evident here; loose Quaternary sediments, the main parent materials, are overlain in places by thin deposits of volcanic ash. The coastal lowland is swampy and the foothills are fairly well drained. Ochric Andosols are associated with Podzols in better-drained areas and include some patches of Vitric Andosols. The coastal lowlands are occupied by Dystric Histosols.

The central Kamchatka soil region (*E1.3*) occupies the central depression of the peninsula between the mountain ranges bordering the Kamchatka river valley. Here the Quaternary deposits are nearly 120 metres thick. Fluviatile deposits are interbedded with volcanic ash. Surface layers of volcanic ash are rather thick. All varieties of Andosols are found here, the main ones being Orthic Andosols and Vitric Andosols. Swamps are common, but do not occupy large areas.

E2. Taiga forest zone of Dystric Podzoluvisols

This zone comprises two plains soil regions on the coast of the Sea of Okhotsk which are separated by mountains.

The Magadan soil region (*E2.1*) occupies a narrow lowland along the coast of the Sea of Okhotsk interrupted by residual hills with altitudes up to 500 to 800 metres. The lowland, formed by Quaternary fluviatile sediments, is almost completely covered by rather open larch forest. Dystric Podzoluvisols predominate in the region, but Eutric Histosols occupy large swampy areas in river valleys near the coast. Dystric Gleysols are usually associated with Podzoluvisols in depressions. Permafrost is often present.

The Amur-northern Sakhalin soil region (*E2.2*) occupies the northern plain portion of Sakhalin Island and the lower plain of the Amur river. Several low mountain ranges diversify the terrain. Larch forest covers the region, and there are large patches of meadow in river valleys. Dystric Podzoluvisols are the main soils, but Gleyic Cambisols are also very important. Lithosols occupy mountain slopes in association with Podzoluvisols or Cambisols; Gleysols and Histosols occur mostly in river valleys.

e. *Mountain soil regions*

These are represented by three separate mountain systems bordering the Sea of Okhotsk.

The Kamchatka soil region (*e.1*) includes the mountain ranges of the peninsula where altitudes vary from 1 000 to 2 000 metres. Most of the active volcanoes are in the eastern range. The mountains consist mostly of basic effusives overlain by volcanic ash. The dominant tundra vegetation covers an I-Gx-Rx soil association. Various Andosols are common, but do not cover large areas, as the shallow soils on the volcanic ash (up to the depth of 10 cm) are classified as Lithosols. In the southern part of the region Andosols are more widely distributed in an I-T association.

The Okhotsk soil region (*e.2*) includes the mountain ranges along the coast of the Sea of Okhotsk with altitudes up to 2 000 metres. The mountains are usually characterized by rough alpine landforms and consist of Mesozoic sedimentary rocks intercalated with acid intrusives. Larch forest occurs at altitudes of 600 to 700 metres, above which tundra vegetation predominates. In this region Lithosol dominants are associated with Dystric Podzoluvisols.

The Sikhote Alin-Sakhalin soil region (*e.3*) is divided into two parts by the Tatar Strait. In its northern portion, the Sikhote Alin range has rather soft relief with altitudes which do not surpass 1 500 metres. It is formed mostly by granites with some sedimentary hard rocks on mountain peaks. *Picea* forest is dominant. Podzols and Podzoluvisols, the main soils of the range, are associated with Lithosols. Mountains formed by Mesozoic rocks, with altitudes up to about 1 000 metres, occupy the southern part of the region. They are dominated by an I-Bd-Dd association. The southern Kuril islands are occupied by a Lithosol-Dystric Podzoluvisol association.

SOIL REGIONS OF THE SUBBOREAL TEMPERATE BELT

This is the main steppe and desert belt crossing the Asian continent from west to east. Environmental conditions vary greatly, and it is subdivided into several large soil-bioclimatic provinces.

G. *Central forest-steppe and steppe province*

This province includes three soil zones comprising 14 plains soil regions and five mountain soil regions with specific soil associations and environmental conditions. It is an important agricultural area, for natural conditions favour cultivation of many different crops, especially grains.

G1. Forest-steppe zone of Greyzems and Luvic Chernozems

Owing to its vast west-east extension, this zone is not homogeneous, although the main soil units are basically the same throughout. Western Siberian, eastern Siberian and Manchurian Chernozems are quite different, not only in their morphological and chemical properties, but also in their agricultural potential, even though they may belong to the same main soil unit. Hence five soil regions are differentiated within this zone of the province:

The western Siberian soil region (*G1.4*) crosses the entire western Siberian plain from the Urals to the Ob river along a narrow belt of meadow steppe with very poor general drainage. Loess-like calcareous loams overlying a thickness of Quaternary sediments are the main parent materials. There are numerous depressions occupied by lakes and swamps. The natural vegetation has been almost entirely destroyed by cultivation, and remains only in moist depressions. Luvic Chernozems and Chernozems with a phreatic phase are the dominant soils. A complex of saline, alkaline and solodized soils occurs in depressions. Among the Solonetz and Solonchaks, sodic and sulphatic varieties are most common. Owing to a very complex microrelief, soil distribution is irregular.

The pre-Altai soil region (*G1.5*) is generally better drained. It is a hilly upland with natural meadow-steppe vegetation; small patches of birch forest are also common. The dominant Luvic Chernozems are associated with Orthic Greyzems. Sandy Regosols and Podzols occur on the terraces of the Ob river. Saline and alkaline soils are uncommon, but do occur on the lower river terraces.

The western pre-Sayan soil region (*G1.6*) is part of a group of regions characterized by soils which are subject to long and deep seasonal freezing and hence are usually gleyed despite an apparently good general drainage. This rolling to hilly area has broad gentle slopes with an intricate microrelief. The main soils are Glossic Chernozems and Gleyic Greyzems, but in places Haplic Chernozems also occur. All soils have a phreatic phase.

The eastern pre-Sayan soil region (*G1.7*) is a rolling to hilly upland composed of Mesozoic sedimentary series overlain by loess-like loams. It has a complex surface pattern resulting in an irregular soil distribution. The tops of hills are usually covered by pine-larch-birch forest on soils that are mainly Eutric Podzoluvisols. Although their extension is small, they are characteristic of the region. Gleyic Greyzems occur on the upper parts of hill slopes where there is long and deep seasonal freezing. Luvic Chernozems with a phreatic phase occupy the plains lying between the hills.

The northern Manchurian soil region (*G1.8*), influenced by maritime climatic conditions, represents the extreme eastern variant of this zone. The region is a rather poorly drained closed basin surrounded by hilly and mountainous terrain. Haplic Chernozems, Haplic Phaeozems, Gleyic Phaeozems and Mollic Solonchaks are associated with Mollic Gleysols.

G2. Steppe zone of Haplic Chernozems and Calcic Chernozems

This broad steppe zone stretches across the continent from the southern Urals to southern Manchuria. Because of its enormous latitudinal extension, it is subdivided into five plains soil regions with different soil associations. Most of it is under permanent cultivation.

The Kazakhstan soil region (*G2.6*) is by far the zone's largest. Because of its great extension, it includes areas that are geomorphologically different, although in general it is a plains area. To the west, it starts from the peneplained upland of the southern Urals formed by Mesozoic folded sedimentary rocks, then follows a vast Paleogene plateau, passing gradually to the ancient alluvial plain of the southern part of the western Siberian lowland, which is characterized by a large number of small closed depressions with Solonchaks, swamps and lakes. Further east, there is a rolling to hilly upland formed by Precambrian hard rocks in central Kazakhstan, after which comes the western Siberian alluvial lowland with a characteristic levelled relief and poor drainage. Haplic Chernozems predominate throughout the northern part of the region, and Calcic Chernozems in the south. The soil pattern of the region is complex and varies with geomorphological and lithological conditions. Saline and alkaline soils are common. Poorly drained low-lying plains are dominated by associations of Solodic Planosols, Solonetz and Chernozems. Saline and alkaline soils are more common in the southern area of Calcic Chernozems.

The pre-Altai soil region (*G2.7*) is a combination of a system of early Quaternary alluvial plains of various levels and ages and a system of Altai pediplains. In the ancient alluvial plains three geomorphological units are prominent: the strongly dissected Ob loess plateau, with elevations of 170 to 320 metres; ancient valleys which dissect the Ob plateau into several uplands at elevations of 140 to 200 metres; and a system of flat terraces of ancient valleys at 120 to 170 metres. The pediplains of the Altai lie at elevations of 200 to 400 metres and have a cover of loess-like heavy loams, while coarse-textured deposits which in places bear vast covers of loose sands characterize the lower plains. The shifting sands which cover a large portion of the region developed when natural vegetation was destroyed in ancient times. Sandy soils are also common. Calcic Chernozems and Haplic Chernozems are the main soils, the latter being mostly concentrated in the eastern part of the region.

The Minusinsk region (*G2.8*) is bordered by the Altai and Sayan mountains on the west and south and includes the western part of the large intermontane Minusinsk depression. It is an upland with altitudes ranging from 220 metres (the level of the Yenisei river) to 500 to 600 metres (the tops of the hills). The depression is filled with Devonian rocks overlain by a thin layer of Quaternary loess and coarser materials. Glossic Chernozems, the dominant soils of the region, occur in association with Haplic Chernozems or Calcic Chernozems.

The intermontane Transbaikalian region (*G2.9*) is an elevated upland with altitudes ranging from 600 to 1 000 metres. The terrain consists of alternating, abruptly defined hilly ridges and broad plains. It is the most continental region of the zone, with very sharply contrasting seasons. Its Glossic Chernozems are shallow, with prominent tongues of humus horizon, and are associated with Haplic Chernozems.

The southern Manchurian soil region (*G2.10*) is a southern continuation of region *G1.8* and encloses the poorly drained basin of the Liao river. It has a rather complex soil cover with Chernozems, Phaeozems and Gleysols. In the southern part of the region, where the terrain is more like an upland of the foothills of the surrounding mountains, Chromic Cambisols predominate under a cover of dry open forest.

G3. Dry steppe zone of Haplic Kastanozems

This southern zone represents the province's more arid regions. Soil properties change markedly throughout the zone from west to east in an orderly manner in accordance with the changes of climate. At the same time, geomorphological and lithological peculiarities of various areas make it necessary to subdivide the zone into several soil regions.

Most of the trans-Volga soil region (*G3.3*) is located in the European part of the U.S.S.R.; only its eastern trans-Ural part lies within the area under consideration. The unreliable and insufficient precipitation makes agriculture very difficult without supplementary irrigation. The area is subject to annual droughts. Geomorphologically, it is a plateau bordering the Urals on the south. The Paleogene clays which overlie Cretaceous rocks are in turn usually overlain by fluviatile Quaternary loams and clays which are mostly calcareous and saline. The Haplic Kastanozems of the region vary greatly in texture, degree of salinity and alkalinity, but all have a sodic phase. Coarse-textured varieties are common in river valleys, where shifting sands (the result of overgrazing in the past) also occur in places. Heavy clay soils usually contain 4 to 5 percent of organic matter in a 40-cm-thick mollic A horizon, while coarse-textured soils may contain as little as 2.5 to 3 percent in a 30-cm-thick horizon.

The Kazakhstan soil region (*G3.4*) is the largest in this zone. The western part includes high dissected surfaces of the southern Ural plateau consisting of Cretaceous and Paleogene rocks covered by brown loams. Further east is a southern slope of the Ural mountains formed by various hard rocks, and then the Turgai plateau with heavy clays, which gives way to the central Kazakhstan hilly plateau, also covered by heavy clays. The eastern part of the region is represented by the flat, sandy plains of the western Siberian lowland near the Irtysh river, where there is a cover of coarse lacustrine-alluvial deposits. Dry steppes represent the natural vegetative cover throughout. The soil cover varies in different parts of the region, although Haplic Kastanozems with a sodic phase are the dominant soils. In the southern Ural plateau it is more or less uniform, comprising heavy-textured Haplic Kastanozems, but there are patches of stony and calcareous soils where hard rocks outcrop. In the Turgai plateau there are associations of Haplic Kastanozems with Solonetz and Solonchaks. Stony soils characterize the central Kazakhstan hilly plateau.

The Tuva soil region (*G3.5*) consists of two closed intermontane depressions separated by the Tannu-Ola range. The bottoms of the depressions lie at elevations of 600 to 1 000 metres and are characterized by rolling to hilly relief interrupted in places by residual mountain ranges. Colluvial fans and alluvial terraces occur widely in the area. Parent materials are usually of medium to coarse texture. The main feature of Haplic Kastanozems here is that they are non-sodic, in contrast to more westerly regions. Soils are often stony and shallow, but not shallow enough to have a lithic phase.

The Transbaikalia-Manchuria soil region (*G3.6*) includes several intermontane depressions with altitudes ranging from 500 to 700 metres. The relief is formed by colluvial fans, piedmont slopes of the surrounding mountains, and ancient alluvial terraces of river valleys. Hence the parent materials vary from coarse-to-heavy-textured deposits of different mineralogical composition. The dry steppes are very poor in plant species and vegetation is sparse. Coarse-to-medium-textured soils predominate, and stony soils are also common. The predominant Haplic Kastanozems are non-sodic, and contain no gypsum or salts for a considerable depth.

g. *Mountain soil regions*

The southern Ural region (*g.1*) includes the portion of the Ural range between Mount Yurma and the Sakmara river. It is a system of low mountain ranges separated by tectonic synclinal depressions. The general elevation decreases gradually toward the south, from 1 600 to 1 000 metres. The geology of the area is very complex. The central part is composed of Paleozoic mica and clay shales, while Permian and Devonian limestones, dolomites, sandstones and shales compose the western slope, and ultrabasic intrusives the eastern one. The eluvium of the above rocks is the main soil-forming material in the region. Lithosols predominate on mountain tops, sometimes in association with Humic Cambisols, or more rarely with Rankers. Mixed coniferous forest with birch covers the mountain slopes, on which Lithosols occur with Orthic Greyzems. In the southernmost part of the region Chernozems occur with Lithosols at lower elevations.

The southern Altai region (*g.2*) is very complex with respect to geology, geomorphology, lithology, vegetation and soils. It is a complicated system of mountain ranges, intermontane depressions and plateaus with altitudes ranging from 600 to 1 000 metres in the depressions, and up to 4 500 metres for the highest peaks. The region is strongly influenced by the great central Asian deserts to the south. There is a very clear altitudinal distribution of landscapes, with steppe tending to predominate throughout the area. The general toposequence of soil belts is: an I-K association at an elevation up to 600 to 800 metres under *Festuca-Artemisia* steppe; an I-C association from 600-800 to 900-1 100 metres under *Stipa* herbaceous steppe; an I-Mo association from 900-1 100 to 1 300-1 500 metres under birch-poplar forest; an I-Bd association from 1 300-1 500 to 2 000 metres under larch-birch forest; and an I-Gx-Rx association above 2 000 metres under montane tundra. The above altitudes vary with slope orientation, lithology and location.

The Altai-Sayan region (*g.3*) includes the Altai, Kuznetsk Alatau, Salair and western Sayan mountain systems. It is a large territory comprising a series of mountain ranges branching from the Altai massif which gradually decrease in altitude toward the peripheries. Traces of an ancient peneplain are clearly visible in the relief. The vast montane plateaus are separated by deeply incised valleys. In the highest parts of the massif a strongly dissected alpine relief occurs. The peripheral, relatively lower parts are also strongly dissected by an elaborate river network. A great variety of environmental conditions in the region make the soil pattern rather complex. Among the soil associations, I-Dd, I-Bd-Dd and I-Dd-Rd are prominent, and the I-Gx-Rx association under montane tundra is also typical for higher elevations. The mountain slopes have a thick cover of coniferous and other forest.

The Khangai region (*g.4*) comprises the Khangai mountains of western Mongolia, where altitudes range up to 4 000 metres. The region, strongly influenced by the Gobi desert to the southeast, is rather arid. The toposequence of soils from low elevations to the tops of ranges begins with Kastanozems in the foothills and is I-K, I-Mo, I-Dd and I-Bh-U in the mountains.

The Greater Khingan region (*g.5*), the easternmost of the province, isolates the Mongolian desert plateau from the influence of the Pacific. The region itself is influenced by the Gobi desert to the west and by the Pacific Ocean to the east, and thus the eastern and western slopes of the ranges have different environmental conditions. Mesozoic and older volcanic rocks, mostly granites, predominate. The mountain slopes are covered mainly by steppe and forest-steppe vegetation. Chernozems and Greyzems with Lithosols form the main soil pattern.

H. *Eastern forest province*

This province forms the eastern border of the Eurasian subboreal belt and includes the Far East region of the U.S.S.R., northeastern China, the northern and central parts of the Korean Peninsula, and northern Japan. It has only one soil zone:

H1. Coniferous broadleaf forest zone of Cambisols and Luvisols

This zone has a continuous cover of mixed coniferous broadleaf forest consisting of several species of coniferous trees and Mongolian oak. It occurs in several mountain systems and intermontane and piedmont uplands. There are two soil regions in the uplands and three mountain soil regions.

The Ussuri-Khanka region (*H1.1*) includes the plains of the Ussuri, Sungari and lower Amur rivers, the foothills of the Sikhote Alin range on the east and the Barreyan ranges on the west. The geology of the region is very complex. Besides the intrusive and sedimentary rocks of various lithology (from acid to basic and calcareous) and age (from Quaternary to Devonian), there are various Quaternary and recent alluvial deposits (heavy clays and loams). The ancient alluvial plain of Birobidzhan is a poorly drained lowland with an elevation of 50 to 100 metres. The Suyphun-Khanka plain, also formed by ancient alluvia, has a series of terraces descending gradually to Lake Khanka. The plain has some isolated 700- to 900-metre-high hills comprised of hard rocks, and is covered by soils rich in oxidic concretions. The Ussuri plain lies at an elevation of 100 to 500 metres, and separate hills reach 600 to 700 metres and even 1 000 metres. This plain is composed of young effusives (basalts and andesite basalts) overlain by Quaternary clays and loams. The region's poor drainage is largely due to the heavy texture of surface materials. The natural vegetation, mainly broadleaf forest with *Quercus mongolica*, has been largely cleared for farmland. Gleyic Luvisols are the dominant soils, and Eutric Histosols are common. Mollic Gleysols and Fluvisols are found along the major rivers.

The Zeya-Bureya soil region (*H1.2*) is an ancient alluvial plain with elevations ranging from 150 to 200 metres in the Amur valley to 300 to 400 metres between the Zeya and Amur rivers. Uplands here are strongly dissected and are rolling to hilly, while the lowlands in river valleys are flat and have a rather high water table. Geomorphologically, it is a depression with a basement of magmatic and metamorphic pre-Paleozoic rocks overlain by a thickness of Tertiary sedimentary rocks which outcrop in the higher plains. The plain, originally covered by oak and oak-coniferous forests, is now largely farmland. Gleyic Luvisols and Dystric Cambisols were formed under these forests. An association of phreatic Chernozems, Mollic Gleysols, Fluvisols and Eutric Histosols occurs in the lowlands.

h. *Mountain soil regions*

The southern Sikhote Alin soil region (*h.1*) completely occupies the Sikhote Alin range, the southernmost part of Sakhalin Island and the northwestern part of the island of Hokkaido. Elevations range from 500 to 2 000 metres. Acid and basic volcanic and metamorphic rocks occur widely. Broadleaf coniferous forest covers the entire area. There is an altitudinal sequence of vegetation and soils on mountain slopes. Pine-oak forest occupies lower positions on Luvisols and Cambisols, the main soils of the region. The common occurrence of Dystric Cambisols and Eutric Cambisols is due to lithology. They are associated with Lithosols, which are dominant on mountain slopes. Andosols occur locally, but are not prominent.

The Lesser Khingan-northern Korea region (*h.2*) occupies mountain ranges with altitudes ranging from 1 000 metres in the north to 3 000 metres in the south. The mountains consist of acid or intermediate intrusives which have undergone a strong weathering that has given a rather smooth topography to the terrain. Lithosols, the main soils on mountain slopes, usually occur with Orthic Luvisols. In somewhat lower positions Gleyic Luvisols are prominent. Where the parent rocks are mainly basic or even calcareous, Eutric Cambisols occur in association with Lithosols. The region is under a thick cover of broadleaf forest.

The northern Japan region (*h.3*) occupies the southeastern part of Hokkaido and the northern part of Honshu, where altitudes range from sea level to about 2 000 to 2 500 metres. Narrow strips of coastal lowlands and river valleys are included in this region, which is geologically complex owing to the great variety of sedimentary and volcanic formations. Basic volcanic rocks, among which Quaternary basic volcanics are prominent, are a specific feature. The region is covered by a thick broadleaf forest which is replaced by coniferous forest on mountain tops. Dystric Cambisols and various Andosols, the most important soils, are associated with Lithosols on mountain slopes. Patches of Podzoluvisols and Podzols occur at higher elevations. Of all the Andosols of the region, Chromic Andosols are the most common.

I. *Desert steppe and desert province*

This large central Asian province consists of three soil zones incorporating 15 upland and lowland soil regions and eight mountain regions.

I1. Desert steppe zone of Luvic Kastanozems and Luvic Xerosols

In general, this rather heterogeneous zone is bordered by dry steppes on the north and deserts on the south, but in the eastern portion of the continent these directions change to east-west as a result of maritime influence. It is subdivided into six plains soil regions:

The relief of the Caspian region (*I1.1*) is level in the Caspian depression and becomes more undulating in the Ust Urt plateau. The surface is also rolling in the areas of shifting sands where sand dunes are prominent. Soil parent materials are mainly marine and lacustrine alluvial surface deposits, and are often saline. Luvic Kastanozems in the north and Luvic Xerosols in the south are the main elements of the region's soil cover. Both have a sodic phase. Solonetz and Solonchaks often occur as associated or included soils in various associations, and as separate soil units as well. Solonchaks cover the land around the Caspian seashore, as the sea is gradually receding.

The Kazakhstan region (*I1.2*) is the largest in the zone, extending from the Mugodzhar hills in the west to the Altai mountains in the east. The northern part is occupied by Luvic Kastanozems and the southern part by Luvic Xerosols, both with a sodic phase. These occur at random with various Solonchaks and Solonetz. Scattered areas of shifting sands occur widely. Coarse-textured soils are common.

The Zaysan region (*I1.3*) is situated in an intermontane depression deeply dissected by numerous ravines and gullies. The terrain is rolling or undulating. The main soils are Luvic Kastanozems, but Haplic Kastanozems also occur; both have a sodic phase. Xerosols are absent. The area is generally much less saline and more suitable for agriculture, especially under irrigation. River valley Fluvisols have been under continuous cultivation since ancient times.

The eastern Altai region (*I1.4*) includes the piedmont slopes and intermontane depressions of the eastern Altai ranges that are covered mostly by loess deposits. The region differs greatly from the previous ones in two aspects: the soils here are nonsodic, and there are only very limited areas of Solonchaks and Solonetz. The presence of some Yermosols reflects the area's more desertic environment.

The eastern Mongolian region (*I1.5*) has even more desertic environmental conditions and a rather irregular soil pattern. The level to undulating upland of the Mongolian plateau is frequently interrupted by low mountain ranges and is surrounded by rough topography. It is one of the largest regions of the province, including nearly the entire area of the Mongolian People's Republic. Luvic Xerosols associated with Orthic Solonchaks occupy the largest part of the region, the steppes of the Gobi desert. Associations of Haplic Yermosols and Orthic Solonchaks also occur here. Luvic Kastanozems associated with Orthic Solonchaks occupy large areas in the north and east, providing the best Mongolian pasture lands. Mountain ranges are covered by Lithosols associated with Luvic Xerosols or Haplic Yermosols. The whole region is extremely arid and is actually a semidesert.

The central China region (*I1.6*) is a southern continuation of region *I1.5*. It includes the Ordos desert, the central part of the Huang Ho river basin, the foothills of the mountain ranges surrounding the central undulating upland, and the Yin Shan mountains in the north and the Luya mountains in the east where altitudes reach 3 000 metres. It is essentially a loess plateau with a semiarid environment. The largest portion of the region is occupied by an association of Luvic Xerosols and Orthic Solonchaks, and a large area by unspecified Xerosols. Eutric Gleysols, mostly saline, occur in the plains of the Huang Ho valley.

I2. Desert zone of Haplic Yermosols and Calcic Yermosols

This zone includes the great deserts of central Asia and consists of eight separate plains soil regions. As they are true deserts, these regions have their own particularities. Agriculture is impossible without irrigation.

The Aral-Caspian region (*I2.1*) occupies the heterogeneous Ust Urt plateau formed by saline Tertiary marine sediments represented in their upper series by limestones and marls. The base rocks are covered by a thin (1-2 m) mantle of eluvial stony loams. This gently undulating plateau with a general elevation of 100 to 300 metres is interrupted in places by deep depressions which are usually 50 to 100 metres lower than the surface and sometimes below sea level. These depressions are mostly occupied by salt flats and shifting sands. In general, the soil association of the region comprises dominant Calcic Yermosols and scattered patches of Solonetz, Solonchaks and salt flats.

The Aral-Balkhash region (*I2.2*) is an eastern continuation of region *I2.1* and occupies a broad belt of ancient alluvial plains. Most of the area comprises gravelly alluvial-colluvial deposits which are overlain by sands and finally by silty clay alluvium at the edges of the plains. All sands are fine-grained and calcareous. They are characterized by dune relief, wide occurrence of Takyric Solonchaks and a relatively high water table. Only in the most ancient sands of the Kyzyl Kum is the ground water very deep. The western part of the Betpak-Dala steppe region is the southern portion of a Tertiary plateau and has a very complex soil pattern. In the eastern part of Betpak-Dala stony soils predominate. Shifting sands occupy a large part of the area. Agriculture is practised in broad river valleys and deltas. Other surfaces are covered by Calcic Yermosols and Haplic Yermosols which are mostly associated with Solonchaks. The region has a good potential for development of irrigated agriculture.

The Dzungarian region (*I2.3*) occupies the deserts of northwestern China surrounded by the Altai ranges on the north and the Tien Shan ranges on the south. It is a broad depression open to the west and east and filled with alluvial-colluvial deposits. In the centre is a large area of shifting sands and around it are level to undulating plains where Haplic Yermosols and Gypsic Yermosols are partly associated with Solonchaks. Stony surfaces occur on Tertiary plateaus.

The Tarim region (*I2.4*) occupies the Tarim basin in the northern part of the Takla Makan desert south of the Tien Shan mountains. The great valley of the Tarim river has a vast flood plain consisting of subrecent and recent alluvial deposits. The climate is extremely dry, but the ground water is near the surface and the river itself brings a supply of fresh water. Because of the high surface evaporation rate, large areas of Orthic Solonchaks and Gleyic Solonchaks occur throughout the valley. Sands, formed by wind erosion of sandy alluvial deposits, are also common. Yermosols occupy the higher terraces and foothills of the northern mountains. The basin of the Tarim river is completely closed. The river receives water from the Kunlun and Tien Shan ranges, especially in the summer when the snows melt in the mountains, but loses it along its course and forms several closed desert lakes, of which Lake Lop Nor is the largest. The Calcaric Fluvisols of the valley are mostly associated with Gleyic Solonchaks and Eutric Histosols, and at higher elevations the association also includes some Yermosols. The area has good prospects for agriculture, but river control work on the Tarim will be rather difficult and expensive.

The Takla Makan desert (*I2.5*) occupies a closed, very wide depression between the Tien Shan and Kunlun ranges. It is a vast area of shifting sands bordered by Yermosols on the foothills of the southern mountains. Several rivers traverse the desert, but they do not flow continuously and are difficult to control. It is one of the largest sandy deserts in central Asia.

The Turfan-Ka-shun region (*I2.6*) is another desert of northwestern China. It includes the deep closed Turfan depression in the north and the rather elevated Ka-shun plateau in the south. It is completely covered by Yermosols and is extremely arid. The area is still unexplored and the soil pattern is not well known at present.

The Gobi region (*I2.7*) is a large desert area including the Ala Shan desert and a large portion of the Gobi desert. It is an upland with a very rough surface covered by rock debris and stones. and resembles the hamadas of northern Africa. Large areas of shifting sands and dunes occur in the northern part. There are several mountain ranges and separate hills with steep slopes or escarpments with only rock outcrops or rock debris, or Lithosols at most. Haplic Yermosols and occasional Solonchaks are the main soils of the region.

The Tsaidam region (*I2.8*) occupies a closed, uplifted intermontane depression surrounded by the Altyn Tagh and Nan Shan mountains to the north and by the Tibetan highlands to the south. A large area of Solonchaks or salt flats in its centre is surrounded by Haplic Yermosols. Several mountain streams have left alluvial fans at the foot of mountains. In general, this desert region is extremely dry.

I3. Piedmont desert steppe zone of Haplic Xerosols

This zone comprises the northern Tien Shan soil region (*I3.1*), a gently undulating piedmont plain bordering the Tien Shan ranges from the north. It has a network of deep valleys with large gravel talus cones. The altitude ranges from 400 to 1 000 metres. Loess is the main soil-forming material covering the gravelly colluvial-alluvial deposits. Haplic Xerosols are the dominant soils. Haplic Yermosols occur in places and Haplic Kastanozems border the region. Various Fluvisols and Gleysols, often saline or sodic, occur in the river valleys. Agriculture under irrigation is successful here and could be expanded.

i. Mountain soil regions

These include all of the most important mountain systems of central Asia. They are similar in general appearance, but the mountains of different ranges show some variations in soil pattern due to differences in geology, lithology, position in relation to the adjoining deserts and degree of continentality. Most of them are still unexplored, and can be only roughly outlined owing to lack of information.

The Saur-Tarbatagay region (*i.2*) occupies the Saur and Tarbatagay mountain ranges. Altitudes reach 3 800 metres in the Saur range and 3 000 metres in the Tarbatagay range. The mountains consist mostly of Paleozoic shales, sandstones, limestones and granites. The foothills are covered by an I-K association, while an I-C association predominates at higher elevations.

The northern Tien Shan region (*i.3*) includes a long chain of mountain ranges of this system branching to the north and northwest of the main Tien Shan range. The mountains vary greatly in geology and lithology, but consist mostly of strongly dislocated Precambrian to Devonian crystalline rocks, with a wide occurrence of granitoids. The altitudes of the different ranges vary from 3 000 to 5 000 metres. Deep gorges and broad intermontane depressions alternate with the ranges. Owing to its large area and geological and other environmental variations, the region does not have a uniform soil pattern. The toposequence of soil associations with increasing altitude is I-K, I-C, I-Bh, I-Bh-U. The latter two associations are dominant throughout the region at high elevations. Rock outcrops are common on steep slopes.

The southern Tien Shan region (*i.4*) is much more arid because it faces the Takla Makan desert to the south. The slopes are steep and rocky. Lithosol dominants are associated with Luvic Xerosols or Haplic Yermosols under sparse desert vegetation.

The eastern Tien Shan region (*i.5*) is a series of high, west-east-trending mountain ranges in the eastern Tien Shan where altitudes reach 5 500 metres. The mountains are surrounded from the north, east and south by the extremely arid depression of central Asia and also have desertic conditions. The steep, rocky mountain slopes are covered by very sparse desert vegetation. Lithosol dominants are associated with Luvic Xerosols and Haplic Yermosols. The terrain is covered by rock debris. At higher elevations alpine meadow occurs on an I-Bh-U soil association.

The Kunlun region (*i.6*) occupies the Kunlun ranges southwest of the Takla Makan desert. Altitudes may reach 7 000 metres and more. The slopes are very sharp and rocky. Hardly any soil cover can be detected over large areas. Rock outcrops, stony mantles and rock debris are the main surface components. Lithosols associated with Luvic Xerosols or Haplic Yermosols may be found on more favourable positions under sparse desert vegetation. The general landscape is very similar to that of the southern and eastern Tien Shan mountain regions facing the central Asian deserts.

The northern Himalayan region (*i.7*) is situated between the Tibetan highlands and the main Himalayan ranges and includes several east-west latitudinal ranges with altitudes up to 7 000 metres. The region is unexplored and is believed to be desertic. Xerosols are the main components of the soil cover on slopes more or less suitable for vegetation, but the greater part of the terrain is rocky.

The eastern Tibet region (*i.8*) is a large area of mountain ranges with steep rocky slopes, deep gorges and snow-covered peaks with altitudes of 6 000 to 7 000 metres. Montane meadow steppe covers the high slopes and desert steppe predominates on lower positions. Xerosols are the main associates of Lithosols on low slopes and are replaced by Kastanozems and Rankers at higher elevations.

The Nan Shan region (*i.9*) is the easternmost of the province's mountain systems. It occupies the Nan Shan ranges and the high-mountain country east of the Tsaidam desert. Mountain slopes are mostly steep and rocky, and altitudes reach 6 000 to 7 000 metres. Lithosols occur with Kastanozems and Phaeozems on the foothills and with Humic Cambisols at higher elevations.

J. *High-mountain desert province*

This province occupies the highest mountain systems of central Asia and consists of three separate regions with unique landscape features.

The central Tien Shan region (*j.1*) is the northernmost of the three. It includes the eastern part of the inner Tien Shan between the Terskey Alatau and Koksha Alatau ranges. The eastern limit of the region is Mount Khan Tengri. Altitudes range between 3 000 and 7 000 metres. The region represents an ancient folded mountain system which was peneplained and then uplifted at the end of the Tertiary. Due to this, broad levelled surfaces, sometimes with flat valleys and lakes, characteristically occur at altitudes of 3 300 to 4 300 metres, and are separated by mountain escarpments. Paleozoic shales, limestones, sandstones and granites characterize the area, but plateaus are covered by loess-like loams. Lithosols and rock debris or rock outcrops occur on the mountain slopes, while the plateau-like surfaces are characterized by Yermosols, especially Takyric Yermosols. The I-Bh association occurs widely on higher slopes.

The Karakoram region (*j.2*) occupies the Karakoram ranges running southeast of the Pamir massif. The region is characterized by broad flat river valleys and lake depressions lying at altitudes of 3 700 to 4 000 metres. These uplifted plains are separated by mountain ranges with altitudes up to 7 000 metres. The flat surfaces are covered by very stony glacial and fluviatile deposits, and the mountain slopes are rocky. Takyric Yermosols are the main soils on flat surfaces and Lithosols and rock outcrops characterize the mountain slopes. Swamps with Histosols and Gleysols which are often calcareous and saline occur in the river valleys.

The Tibet region (*j.3*) is the largest high-mountain region of the world. Broad flat surfaces occur frequently at high elevations between mountain ranges. It is a specific high-mountain cold desert with a very cold, dry climate and sparse vegetation. An association of Lithosols and Yermosols occurs on the level surfaces. The Yermosols (most of which are Takyric Yermosols) have prominent polygonal surfaces. The widely occurring I-Gx association is most characteristic of the region. The Gelic Gleysols are similar to those of tundra landscapes, but are mostly saline. Ice caps are prominent in the landscape, and there are numerous lakes.

SOIL REGIONS OF THE SUBTROPICAL WARM TEMPERATE BELT

K. *Subtropical humid forest province*

This province includes a number of soil regions of southern China, the Republic of Korea and southern Japan. It consists of two soil zones under humid subtropical forest, the second of which is a transition to tropical conditions and occupies only the southernmost areas of southern China and Hainan Island.

K1. Humid forest zone of Orthic Acrisols and Ferric Acrisols

The Chungking soil region (*K1.2*) of southern central China is one of the most peculiar in the world. It includes the strongly dissected hilly upland of the Szechwan basin surrounded by mountain ranges. The region consists of a series of Mesozoic (mostly Cretaceous) rocks. Among the Cretaceous rocks, the so-called violet clay shales are the most prominent. The deep purple colour of the soils (Chromic Cambisols of heavy texture) originating from these shales is a result of the presence of large quantities of iron and manganese oxides in specific mineralogical forms. These soils are well structured with strong microaggregates, and are well drained. In the numerous river valleys traversing the region they are associated with Gleysols, which predominate in the flood plains. Especially large areas of Gleysols occur in the Yangtze valley.

The southern China region (*K1.3*) includes the hilly country south of the Yangtze valley. It is an upland dissected into large blocks by river valleys. Precambrian crystalline sedimentary rocks predominate throughout the area and there are also Paleogene deposits. In river valleys these are covered by fluviatile deposits, and on slopes eluvial deposits predominate. Elevations gradually increase from the Yangtze valley southward to the Nan Ling and Bohea mountain systems. Orthic Acrisols and Ferric Acrisols predominate in the region.

The western Taiwan region (*K1.4*) is very complex. It includes large lowlands as well as foothills. Coastal plains extend inland as far as 40 km in the south and only several kilometres in the north. The northern part of the plains is somewhat elevated, and is rolling to hilly. Between the coastal plains and the foothills a series of ancient terraces occur from Taipei down to the southern tip of the island. The uplands of the region consist of Miocene and Pliocene sandstones and shales, and the coastal plains are covered by various alluvial deposits. The terraces consist mostly of thick gravel beds covered by a mantle of clayey detritus. Hence the soil cover of the region has various patterns. Gleysols and Fluvisols occur in the coastal plains, and Solonchaks in a narrow strip along the coast. The so-called Taiwan clay soils, which have many of the characteristics of Vertisols, occur among the Gleysols of the plains. Uplands are occupied by Ferric Acrisols.

The lower Yangtze region (*K1.5*) occupies the lower portion of the Yangtze valley and the adjoining uplands. The valley is very broad and has several terraces. Numerous lakes surrounded by swampy areas occur here and there. The broad delta plain is one of China's most densely populated areas. The land is completely utilized for agriculture, and the area's Gleysols, Vertisols and Fluvisols have been greatly transformed from their original state into man-made soils. Paddy soils, e.g. the famous "rice podzols" or "degraded paddy soils," occupy large areas; some of them would be classified at present as Planosols. The complexity and agricultural importance of the region are too great to be dealt with in this short description. Special publications should be consulted for a proper knowledge of its soil pattern.

K2. Humid forest zone of Ferric Luvisols and Orthic Acrisols

The Annam-Tonkin region (*K2.1*) extends into small areas in southern China, including the Luichow Peninsula and Hainan Island. Its relief is varied, ranging from the coastal plains of the mainland to the mountains of Hainan where altitudes reach 2 000 metres. Its climate, vegetation and soils are essentially those of a tropical environment. The soil pattern is complex, showing a predominance of Ferric Luvisols in the plains and lowlands. The highlands and mountains of Hainan are dominated by Orthic Acrisols and Ferric Acrisols.

k. *Mountain regions*

The soil patterns of the province's ten mountain regions vary greatly according to geology, lithology, altitude, and the position of the mountain system.

The southern Himalayan region (*k.3*) covers the great ranges of the Himalayas where altitudes reach 7 000 metres. It is high-mountain country with sharp peaks, deep gorges, steep rocky slopes and broad alluvial plains. The latter include some swamps with Dystric Histosols. The main soil pattern of the region is characterized by an I-Bh-U association under alpine meadow. Snow caps occur on the highest peaks, and rock outcrops and rock debris are common.

The eastern Himalayan region (*k.4*) includes high mountain ranges with a north-south trend. The terrain is dissected by deep gorges occupied by the upper valleys of rivers such as the Salween, Mekong and Yangtze. The regularity of the soil pattern is determined by the altitude. At high elevations an I-Bh-U association occurs under alpine and subalpine meadows. The upper parts of the valleys have an I-K-U association under high-mountain meadow steppe. At lower elevations Cambisols occur under mixed coniferous and broadleaf forest. Rock outcrops and rock debris occur frequently on steep mountain slopes.

The southern Korea region (*k.5*) occupies the southern part of the Korean Peninsula, including its mountain ranges, hilly uplands, and river and coastal plains. Mountainous terrain predominates, running in a backbone southward along the east coast, with lateral branches and spurs extending in a southwesterly direction. The slopes to the east are steep and those to the west are gentle. The southernmost part of the region is more hilly than mountainous. The lowlands comprise both the coastal plains, with fluvio-marine deposits of silty to clayey materials, and the continental alluvial plains and valley flood plains of the interior. Not far from the west coast there is an extensive area of rolling pediplains which passes further inland to a hilly area strongly dissected into a series of erosion surfaces. Then the mountain country appears with its sequence of ancient plateau remnants. Rocks of all ages from Precambrian to recent occur scattered throughout the region; the most important ones are late Archeozoic gneisses and granites. I-Af-Bd is the most widely distributed soil association in hilly and mountainous areas. The plains are covered mostly by Orthic Acrisols and Dystric Cambisols or Eutric Cambisols. River valleys are occupied by Gleysols and Fluvisols. The southern and western plains are densely populated and have a variety of soils greatly altered by centuries of cultivation.

The southern Japan region (*k.6*) includes the islands of Kyushu, Shikoku, the southern half of Honshu, and a number of small offshore islands including the Ryukyu group. The region is mountainous or hilly throughout with small lowland areas along the sea coasts and river valleys. The terrain is geomorphologically, geologically and lithologically complex. There are many recent and subrecent volcanic rocks including tuff, lava flows and ash. The presence of Acrisols under humid subtropical forest separates this region from the northern one, although here too Dystric Cambisols and Eutric Cambisols are the main soil cover on mountain slopes. Andosols are abundant, making this region rather specific in the province.

The Tapieh region (*k.7*) is a series of mountain ranges with altitudes up to 2 000 metres separating the Yangtze and Ying alluvial plains in eastern China. The mountains are not very steep and consist of Archean crystalline rocks including gneisses and micaschists. They have a dense forest cover. Cambisols predominate in the soil pattern.

The northern part of the upper Yangtze region (*k.8*) includes the Ch'in Ling mountains, where altitudes reach 4 500 metres, and the southern part, belonging to the eastern Himalayas, is occupied by the Tahsueh range with altitudes up to 7 000 metres. As is characteristic for the Himalayas, the mountains have steep rocky slopes separated by deep gorges, and occasional high elevated plateau surfaces. Rock outcrops, rock debris and Lithosols are the main surface features of this region, which has a dense forest cover. The toposequence of the distribution of vegetation and soils on the mountain slopes is altitudinal. Small areas below summit snow caps are occupied by Rankers under alpine meadow. Then come Cambisols under coniferous and broadleaf forests. The lower slopes are covered by various associations of Orthic Acrisols and Ferric Acrisols under humid subtropical forest.

The Shan plateau region (*k.9*) represents a large, strongly dissected and eroded ancient mountain system with altitudes of about 2 000 to 3 000 metres. It has rolling to hilly tablelands separated by depressions and mountain ranges. The plateau consists mostly of Paleozoic limestones, dolomites, argillites and shales with occasional intrusions. The region has a thick cover of pine and broadleaf forests. A few rock outcrops occur on the steepest slopes. The tablelands of the plateau are covered by deep friable soils rich in oxidic concretions. Ferric Acrisols are the main soils. They are mostly shallow (with a lithic phase). The region has a very uniform soil pattern. The main variation is in the thickness of the soils, which depends mostly on the slope. The predominating dark red to purple colour of the soils is due to the presence of many oxidic concretions.

The Nan Ling region (*k.10*) is a large plateau area east of region *k.9* with altitudes of about 2 000 to 2 500 metres. It is of great geological complexity, consisting of many crystalline, sedimentary and volcanic hard rocks of all ages from Archean to recent. Despite this, its soil pattern is very uniform. It is completely covered by Orthic Acrisols of varying thickness depending on the slope and lithology of underlying rocks. Shallow (lithic phase) soils and Lithosols occur occasionally. The region is completely covered by dense humid subtropical forest.

The southern China region (*k.11*) includes a low mountainous to hilly area of the Hsi river basin, small coastal plains and the alluvial plain of the Hsi delta near Canton. This is also a geologically complex region, consisting of a variety of crystalline rocks.

Agriculture flourishes in river plains along the coast and in the foothills. The hills and mountains are covered by Ferric Acrisols and Lithosols. Gleysols and Fluvisols are the main soils of the delta and coastal plains. Ferric Luvisols with a petric phase occur on ancient terraces.

The Bohea region (*k.12*) comprises hills and mountains with altitudes up to 2 000 metres. They are composed of a variety of intrusive and volcanic rocks which are mostly acid and intermediate. Orthic Acrisols are the main soils of the region. On steep mountain slopes they are associated with Lithosols and are mostly shallow. Ferric Acrisols, Gleysols and Vertisols occur in broad intermontane depressions and in the coastal plains.

The eastern Taiwan region (*k.*13) presents a rugged mountainous backbone with several peaks exceeding 3 000 metres, and runs the entire length of the island. In the north, east and extreme south, the mountains drop abruptly to the sea. The eastern slope of the mountain range is extremely steep, while the western one descends gradually through a foothill zone and successive terraces to merge with the plains. The ranges are formed chiefly by geologically young rocks, except for a belt of partly metamorphosed schists and crystalline limestones along the eastern flank of the central range. I-Ao and I-Af associations cover the foothills, while Cambisols predominate at higher elevations. An I-Bk-U association occurs on high peaks under subalpine meadow.

L. *Subtropical xerophytic forest province*

This province occupies the lowlands and uplands of eastern China facing the Yellow Sea and includes the north China plain with the vast deltaic plain of the Huang Ho (Yellow) river. The province has one soil zone with three plains soil regions.

L1. Xerophytic forest zone of Chromic Cambisols and Calcic Cambisols

The Ch'in Ling region (*L1.2*) borders the north China plain from the west. The topography is varied, including the Ch'in Ling and Luya ranges with altitudes up to 4 000 metres, and the hilly uplands adjoining the great plain on the east. The region is divided into two parts by the Huang Ho river valley with the huge San-men reservoir. The southern part is mountainous and the northern part has a gentler surface with rolling to hilly uplands. It has many different sedimentary rocks ranging in age from Paleozoic to Quaternary, most of which have been strongly folded and metamorphosed. Large areas of intrusives and volcanic rocks also occur. I-Be and I-Bc soil associations characterize the mountain slopes, where Cambisols are mostly of lithic phase and rock debris are a common surface feature. The uplands are covered by Calcic Cambisols and Chromic Cambisols under dry open forest. Gleysols and Fluvisols occur in river valleys, where they are almost completely under cultivation.

The Shantung region (*L1.3*) occupies the mountainous to hilly Shantung Peninsula and the eastern part of the north China plain. Strongly metamorphosed Archean hard rocks form the mountains, while Mesozoic rocks occur chiefly at the edges of the region. Open xerophytic forest covers foothills, and broadleaf forest occupies higher positions. Chromic Luvisols characterize the foothills, and an I-Be association occurs at higher elevations.

The northern China region (*L1.4*) is one of the most important from the agricultural point of view. It includes the north China plain, a combined river delta of enormous dimensions which is filled with silty and clayey alluvium. Mollic Gleysols and Eutric Gleysols, often saline, occupy the major part of the plain, and are associated with various Fluvisols near the river beds. Gleyic Solonchaks occur in places, and calcareous soils are quite common. The plain is densely populated and is well drained by a network of drainage canals. Centuries of cultivation have altered the appearance of most of its soils. Every bit of land not utilized for a settlement or road is under cultivation. Innumerable small paddy fields cover the plain, and rainfed farming also flourishes.

M. *Subtropical desert steppe and desert province*

This province includes middle Asian deserts and mountain ranges with piedmont plains lying between the Caspian Sea and the central Asian mountain systems. It consists of two zones and a number of mountain regions distinguished on the basis of climatic conditions. Rainfed farming can still be practised in the desert steppe zone, although with poor results, but not in the desert zone.

M1. Desert zone of Calcic Yermosols and Takyric Yermosols

This zone occupies the largest part of the province, including the Kara Kum and Kyzyl Kum deserts of the Turan lowland south of the Aral Sea. It stretches from the Caspian Sea on the west to the piedmont loess plains on the east and south. Its northern boundary is more or less tentative, as the transition to the northern subboreal deserts of the Aral-Caspian basin is very gradual. Cultivation requires irrigation in all parts of the zone except in some depressions or river flood plains where ground water is near the surface and is non-saline. The soils are generally more calcareous, more saline and less alkaline than in the adjoining northern deserts. Shifting sands occupy very large areas. The zone includes two plains soil regions (*M1.1* and *M1.2* on the map).

The desert landscapes of the Turan soil regions vary according to environment. Sand deserts, gravelly clay deserts of ancient plateaus and residual uplands, loamy clay deserts of dry ancient valleys, contemporary river valleys and irrigated oases are easily distinguished. Sand deserts are represented by shifting sand dunes partially stabilized by vegetation. Gravelly clay deserts of ancient plateaus and residual uplands are covered by Calcic Yermosols which are often gypsiferous. These soils could be productive under irrigation, but they are difficult to irrigate owing to unfavourable relief.

M2. Piedmont desert steppe zone of Calcic Xerosols

This zone includes three separate regions situated in the foothills of the large mountain systems of middle Asia. The best agricultural land of he province is in the Fergana valley, the Tashkent and Samarkand oases of Uzbekistan, the Dushanbe and Vakhsh oases of Tadzhikistan, the Ashkhabad oasis of Turkmenistan, the Turkestan oasis of Kazakhstan and the Betpak-Dala. Calcic Xerosols, the dominant soils, could be cultivated under rainfed conditions, although not with the best results.

The western Tien Shan region (*M2.2*) occupies the northern part of the zone. Its geomorphology and lithology are not uniform. It includes the undulating loessial uplands of the Turkestan area, the loess plains of upper terraces and gravelly lower terraces of several rivers, the colluvial loamy piedmont deposits of eastern Fergana, the gravelly and loamy piedmont plains of western Fergana, the saline lowlands of central Fergana, the loessial piedmont plain of the Betpak-Dala, the undulating loessial piedmont plains of Sansar, the upper and lower terraces of the Zeravshan river, and the undulating loess plains of Samarkand. Calcic Yermosols, the dominant soils throughout the region, vary greatly in degree of salinization and in humus content. A large portion of the area is now under irrigation.

The pre-Gissar region (*M2.3*) occurs south of region *M2.2*. Here the piedmont plains are also strongly dissected by a deep, dense network of river valleys. The plains are mostly covered by loess-like loams, and in river valleys and in areas of colluvial cones the loams are underlain by gravel. All the parent materials are highly calcareous. The loess-like loams of the region are heavier in texture and are of a peculiar rose colour due to the occurrence of red clays in the mountains. At lower elevations irrigation always causes secondary salinization, but well-drained non-saline soils predominate throughout the area.

The pre-Kopet Dag region (*M2.4*) occupies a limited belt of piedmont uplands north of the Kopet Dag mountains. The area is rather complex, comprising loess-like loams, sandstones and gravel. Tertiary clays and more ancient rocks occur in places. The Calcic Xerosols of the region vary in texture accordingly, but are mostly stony and shallow. The relief is rolling to undulating. Agriculture is limited to river valleys.

m. Mountain regions

These include three separate regions:

The western Tien Shan region (*m.1*) occupies mountain ranges with altitudes of 3 000 to 3 500 metres. Several altitudinal soil belts may be distinguished, beginning with Calcic Xerosols on foothills up to about 1 300 metres. Chromic Cambisols under open forest occur up to 2 000 to 2 500 metres. The summits of mountains are covered by Humic Cambisols under subalpine meadow. Lithosols predominate in all three belts. Rock outcrops and rock debris are common. The mountain slopes are steep and rocky.

The Badakhshan-Gissar region (*m.2*) includes all the southern mountain ranges up to the western Pamirs. Owing to its more southerly position and warmer climate, it has mostly Calcic Xerosols on mountain slopes up to about 1 800 metres. Only higher slopes are covered by I-Bc and I-Bh associations.

The Kopet Dag region (*m.3*) has the same altitudinal pattern of soil distribution, but at somewhat different elevations. In the lower belt of the Kopet Dag (up to about 1 200 metres), Calcic Xerosols occur on compact clays, limestones and other hard rocks, and on loess in some small areas. Above this is a belt of open forest and shrub on Chromic Cambisols. The highest elevations have alpine and subalpine meadows on Humic Cambisols and Rankers. Lithosols predominate throughout the region and there are many rock outcrops and rock debris.

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6. LAND USE AND SOIL SUITABILITY

Only a small portion of North and Central Asia is used for agriculture; large areas remain under natural vegetation, or are occupied by deserts and rocky terrain and are not suitable for any kind of agriculture, and still larger areas are covered by forest. Topography and climatic conditions are very unfavourable for agriculture in the greater part of the continent.

The most densely populated areas include eastern China, Japan and the subarid zones of middle Asia. Indeed, the plains of eastern China are one of the most densely populated areas in the world. Among the thinly populated areas are the tundra and forest belts of Siberia and the deserts and semideserts of middle and central Asia including Tibet. In Siberia the population is concentrated in scattered settlements along the main rivers.

The total population of the continent, including China, Mongolia the Korean Peninsula, Japan and the Asian part of the U.S.S.R., is rather difficult to estimate, but it is safe to assume that it is about 1 100 million. About half of the total active population is employed in agriculture, cultivating no more than 10 percent of the total surface area and using about 20 percent as grazing land.

The general level of agriculture varies greatly from very high intensity in Japan, China, or certain parts of the U.S.S.R., to low intensity in some parts of central Asia. It varies from country to country, and from one place to another, and it is very difficult to make precise estimates because statistical data are not readily available for the area as a whole, or not available at all in certain specific areas. In a number of areas a substantial increase in production through better use of the soil already under cultivation is feasible as a complementary possibility to the cultivation of new land. The main problem for the expansion of cultivation is the availability of water for irrigation in arid areas, where vast lands are lying bare.

Further improvements can be obtained through better management practices such as intensive fertilization, irrigation, drainage, erosion control, and the introduction of better varieties of plants and breeds of animals.

Intensification of agriculture must be planned in accordance with soil and climatic conditions.

The following considerations on the land use and soil suitabilities of the dominant soils are given in alphabetical order of soil unit symbols. This review is short, and gives only a general idea of the utilization of certain soils without taking into account various local particularities.

A. Acrisols

Af. Ferric Acrisols

These soils occur widely in southeastern China and the uplands of western Taiwan. They are usually deep, of medium to heavy texture, and of a reddish colour. They generally occur on thick debris from weathered sedimentary consolidated rocks or sometimes granites. They have been widely used for agriculture for centuries and are still under intensive cultivation. Rice, tea and a great variety of other tropical and subtropical crops are grown on these soils. Although the area is hilly, paddy is successfully cultivated in the summer on irrigated narrow flat terraces on hill slopes. Other summer crops include maize, sorghum, sugarcane, tobacco, soybeans and potatoes. In the winter, wheat, peas and poppies are grown on the same fields. Cotton, jute and citrus are also of importance. Tea is grown on the higher hills. The utilization of the land is surprising: wheat is grown under orange trees, and between the trees beans may be sown. Between the winter and summer crops a fodder crop is sometimes grown. This region is an important sericulture centre, and also supports large herds of pigs and goats. The population density in areas of these soils may reach 1 000 per square kilometre. The relief does not always favour cultivation, especially in mountainous areas, but where it is favourable the land is utilized up to 100 percent, both area- and time-wise.

Ferric Acrisols are usually associated with Lithosols and Orthic Acrisols in mountain regions, and in the plains Gleysols and Fluvisols are included along river valleys. They are very suitable for both traditional and improved farming systems. Intensive fertilization and improvement of irrigation and drainage systems may help increase soil productivity. At present these soils are among the best and most productive in southeastern China. Climatic conditions are also very favourable, making it possible to grow two or three crops a year. The evergreen forest covering the mountains gives valuable timber and other forest products, but forestry must be improved.

Ag. Gleyic Acrisols

These soils are not dominant in any of the map units of the Soil Map of North and Central Asia, but do occur in the valleys of southern China in association with Ferric Acrisols. In fact, many of the Ferric Acrisols became gleyic after centuries of paddy cultivation owing to prolonged seasonal inundation. Gleying also occurs in depressions because of natural saturation by ground water. This is clearly seen in many river valleys where a rather gradual transition from Fluvisols through Gleyic Acrisols to Ferric Acrisols may be observed in cross section. These soils are typically under paddy and produce a good crop according to local standards, but with improved practices they could be much more productive.

Ah. Humic Acrisols

Humic Acrisols are not shown on the map as dominant soils. They occur in association with Orthic Acrisols and cover high-mountain slopes under thick forest. As they occupy unfavourable positions on steep slopes, they are very rarely under cultivation. Moreover, they are extremely acid and would be unproductive for agriculture. They contain a very low level of plant nutrients and thus are best suited for forest.

Ao. Orthic Acrisols

Orthic Acrisols are the most widespread soil unit in southeastern China, the Republic of Korea and southern Japan. The proportion of these soils used for agriculture varies in different regions. Where topography is too steep for agriculture they are mostly covered by subtropical evergreen forest, but in the coastal regions of Japan, in the Republic of Korea and in the valleys of southern China, where topography is suitable, they are under various extensively cultivated crops, especially rice.

They have a rather low natural fertility, being acid and poor in nutrients. Under improved management the fertility problem can be solved, but other problems remain, such as predominantly rolling to hilly topography. As these soils are strongly differentiated into horizons, of which the deeper ones are rather clayey and compact, susceptibility to erosion is a serious problem. Large, strongly eroded areas are scattered here and there and should be appropriately protected. Forestry also needs some improvement.

Ap. Plinthic Acrisols

Plinthic Acrisols occur sporadically in southern China in association with Ferric Acrisols or Orthic Acrisols. They occur in flat or undulating areas in broad valleys or on the lower parts of slopes on acid parent materials. Most are not used for farming and are covered by forest. These soils are of low fertility, acid, and have unfavourable physical properties. Their agricultural utilization depends on the depth of plinthite; if it is too near the surface as a result of erosion, they are difficult to cultivate and are best kept under forest.

B. Cambisols

Bc. Chromic Cambisols

Chromic Cambisols occur widely in the Szechwan basin and in the hilly areas west of Shantung in eastern China. They are derived from purplish sandstones and schists in the Szechwan basin and from loess deposits in the Shantung area. In mountain areas they occur in association with Lithosols and rocky land. They also occur in the upper parts of the northern piedmont slopes of the mountain ranges of middle Asia, where they are usually calcareous and are associated with Calcic Cambisols.

These soils are utilized for both cultivation and grazing, but their productivity depends on the rainfall, which is not very reliable and often sparse. The rains are seasonal: in middle Asia they occur in the winter, and in eastern China in the summer. The insufficient water supply is the main problem for farming. Wherever irrigation is possible, these soils will produce a good crop, but the topography is generally unfavourable for irrigation in the areas where they occur. Their natural fertility is mediocre, but with fertilization and irrigation they will show a good response.

Bd. Dystric Cambisols

Dystric Cambisols occur in three different types of environment. First, they characterize the temperate forest belt of eastern Asia comprising the

Korean Peninsula, central Japan, northeastern China and the eastern part of the U.S.S.R., and are generally associated with Lithosols and rock outcrops. They cover the slopes of hills and low mountains under mixed coniferous-broadleaf forest.

These soils are also associated with Dystric Gleysols and Dystric Podzoluvisols, all of which have a phreatic phase. This association occurs on the terraces of the Ob river valley in the western Siberian lowland under coniferous forest. The ground is generally moist, with a high water table and poor drainage.

They also occur in separate large areas in southern Japan in association with Acrisols and Andosols under broadleaf forest.

The soils of these regions, although having similar morphological and chemical properties to account for their common classification, are very different from other points of view, as can be seen in their soil associations. In the mountain areas of the first of the above regions they carry good forest, but are generally unsuitable for cultivation because of topographical limitations. Nevertheless, in topographically favorable areas, e.g. the Zeya-Bureya region, they carry a number of extensively cultivated crops. In the western Siberian lowland they are under forest and are not suitable for crops because of excess water and poor drainage conditions; these regions are also sparsely populated. In Japan they are cultivated where topography is favourable. They are generally acid and of low fertility, and occur under a humid climate. They are poor soils for improved management, and on steep topography should be kept under forest.

Be. Eutric Cambisols

These soils are dominant in the rolling plains of Japan and the Korean Peninsula. In association with Lithosols, they cover large areas in the mountains of eastern Asia, including parts of the U.S.S.R., China, the Korean Peninsula and Japan. The latter association is the most widespread. Where they occur in association with Lithosols on mountain slopes, the limiting topography makes them unsuitable for agriculture and they are covered by dense broadleaf forest. In hilly plains with better relief conditions they are under cultivation and are considered good soils, having good drainage and moderate fertility. However, they need fertilization under improved management.

Bf. Ferralic Cambisols

Ferralic Cambisols occur locally in the western plains of the Korean Peninsula, where they are partly under cultivation and partly under forest cover. They have rather low fertility and are very susceptible to water erosion owing to rather unfavourable physical properties and rolling to hilly topography. These plains have already been severely eroded as a result of centuries of traditional farming, and efficient erosion control is now badly needed.

Bg. Gleyic Cambisols

Gleyic Cambisols occur widely in the northern part of the western Siberian lowland in association with Dystric Gleysols and Gleyic Podzols under coniferous taiga forest, and also in the upper Zeya hilly region of the southern taiga subzone in association with Dystric Cambisols, Gleyic Podzoluvisols and Histosols. The higher terrain is covered by good-quality forest, and lower areas are swampy. These soils are generally unsuitable for cultivation owing to poor drainage and excess moisture. The forest is also of the poorest type. As these areas are very sparsely populated, there is no urgent need to bring such soils under cultivation. But where this is to be done, extensive drainage work will be necessary.

Bh. Humic Cambisols

Humic Cambisols occur in central Asian mountain regions in association with other soils (mostly Lithosols) and rock outcrops. They characteristically occur in association with Lithosols and Rankers under alpine and subalpine meadow in the Tien Shan, Pamir, Karakoram, Kunlun, Tibetan and Himalayan ranges. They cannot be cultivated, but they are the best soils of these areas for high-mountain summer pasture, and are extensively used for grazing. However, the plant cover of the grazing grounds needs improvement.

Bk. Calcic Cambisols

These soils occur in association with Xerosols in the semiarid steppe zone of central China in the southern part of the Loess plateau. The area is badly eroded by water and wind, and very poor in water resources. The sparse rainfall results in only poor yields from quick-growing crops, such as certain wheat, sorghum and millet varieties selected by generations of farmers. As the loess plain is deeply dissected by a dense network of deep gullies and ravines, large-scale irrigation is not possible. Farming flourishes only in some deep river valleys and along the less dissected southern foothills where rainfall is higher.

Bx. Gelic Cambisols

These are the soils most typical of central and eastern Siberia, and cover large areas east of the Yenisei river. They occur in the plains and uplands of Siberia within the permafrost zone, and characterize the eastern Siberian cryogenic taiga province of the boreal cold temperate belt (see Chapter 5). This is the largest area of coniferous taiga forest. The climate of the province is extremely continental and cold and the growing season is very short. Only the central Yakutian plain, broad intermontane depressions and river valleys south of the Arctic Circle are suitable for agriculture. The territory is generally very little exploited and sparsely populated. Only along river valleys are there settlements and cultivated fields. All the regions of the province are characterized by dominant Gelic Cambisols in association with other soils, mainly Dystric Gleysols and Gelic Gleysols. In central Yakutia there is an association with Calcic Cambisols, Solonetz and Solodic Planosols. Histosols occur widely in depressions. Gelic Regosols occur in the soil associations of mountain ranges and plateaus.

Use of Gelic Cambisols is very limited owing to climatic and soil factors. The cold, dry continental climate has a short summer, and precipitation is insufficient. Moreover, the permafrost is a very severe limitation to cultivation, depending, of course, on its depth. Where the permafrost is within 100 cm of the surface, cultivation is practically impossible, or at least is very difficult. On deeper-lying permafrost farming is possible, but only short growing season crops are successful. These soils are suitable for grazing and some fodder crops.

Generally speaking, they are also suitable for frost-resistant forest trees with not-too-deep root systems. Of these, Siberian larches and pines are the best. Cultivation should be concentrated on other soils along the rivers.

C. Chernozems

These soils form some of the best arable lands of the continent, and have been under cultivation for centuries. Chernozems with a phreatic phase characterize the northern steppes of Siberia and central Manchuria. They occur in flat plains, mostly on river terraces with ground water near the surface, and usually in association with Mollic Gleysols and sometimes with Solodic Planosols, Solonchaks and Histosols. The soils here are among the best, as crops are rarely affected by drought, usually the scourge of other Chernozems. A number of food and cash crops are grown in these areas, but application of fertilizers is always necessary.

Cg. Glossic Chernozems

Glossic Chernozems occur in the isolated steppes of eastern Siberia and western Manchuria. They resemble very much the Haplic and Calcic Chernozems of other regions, but are shallow and show prominent tonguing of the dark-coloured A horizon into the underlying horizon. As is usual for Chernozems in general, they are almost completely utilized for cultivation, producing fair yields of various crops. They require erosion control and fertilization.

Ch. Haplic Chernozems

Haplic Chernozems occur in the northern part of the steppe zone of the western Siberian lowland, Kazakhstan and the pre-Altai region. The three main limitations of these soils are gully erosion, water shortage, and lack of available plant nutrients, especially nitrogen and phosphorus. Hence improved management should include more efficient erosion control, increased use of fertilizers, and irrigation to eliminate the effects of frequent droughts.

Ck. Calcic Chernozems

These soils characterize the southern part of the Chernozem steppe zone of the western Siberian lowland and Kazakhstan. The above limitations are even more pronounced here, and salinity and alkalinity are also often present. Mollic Solonetz are usually associated with these soils. Droughts are frequent, and irrigation is required for improved farming. Under irrigation, secondary salinization must be carefully controlled, as the subsoil is generally saline.

Cl. Luvic Chernozems

These are the northernmost Chernozems of the forest-steppe zone. In the western Siberian lowland they are often associated with Solonetz, Solodic Planosols and Greyzems. These soils require heavy fertilization and some liming. Erosion control is also very important.

D. Podzoluvisols

Dd. Dystric Podzoluvisols

Dystric Podzoluvisols occur widely as dominant soils in many regions of Siberia, and in association with Lithosols in the mountains. They characterize the middle taiga coniferous forest of Siberia and are rarely used for agriculture. Their characteristic association with Dystric Gleysols indicates poor drainage conditions. They are acid and have a very low natural fertility. If these soils are brought under cultivation, improved management would require a high level of initial investment including forest removal, construction of a drainage network, heavy liming, and applications of both organic and mineral fertilizers. At the same time, they produce fairly good forest stands, and as such are among the best forest soils. Considering the conditions of the region, forestry is probably the best land use.

De. Eutric Podzoluvisols

These soils occur under the southern taiga coniferous and mixed forests of Siberia. Their extent in the plains is equivalent to or larger than that of Dystric Podzoluvisols, but not in the mountains. As they occur in sparsely populated forest areas, they are generally not used for agriculture. They are usually associated with various Gleysols and Histosols. They have the same drainage problems as Dystric Podzoluvisols, but less severe problems of acidity and fertility.

Dg. Gleyic Podzoluvisols

Gleyic Podzoluvisols occur under the northern taiga coniferous forest of the western Siberian lowland and are found scattered in small areas elsewhere in the Siberian forest belt. They are usually associated with Gleysols and Histosols, representing a transition from the swamps to better-drained ground. In the northern taiga they are "zonal" soils, occurring in low flat depressions in association with Dystric Histosols and Dystric Gleysols. These soils are mostly under forest and are rarely used for agriculture. Very poor drainage and their excess moisture, high acidity and low fertility limit their utilization. In addition, the areas of their occurrence are very sparsely populated. Only some better-drained areas near rivers are cultivated at present.

G. Gleysols

Although impeded drainage and a high water table are major limitations for these soils, they vary widely as they are distributed throughout the continent. In the tundra they are gelic, but in the deserts they are calcareous and may be saline or alkaline. They have very different land uses and suitabilities.

Gc. Calcaric Gleysols

Large areas of Calcaric Gleysols occur in the north China and Yangtze plains, and along river terraces in middle Asia. They are usually associated with Solonchaks, Eutric Gleysols and Mollic Gleysols, and with Fluvisols along rivers. They are often slightly saline. Most have been under cultivation since ancient times. In the north China and Yangtze plains they are almost completely covered by countless fields of rice, sorghum, millet, maize, soybeans, potatoes, sweet potatoes, cotton, hemp and groundnuts. In middle Asia paddy and several other crops are grown under irrigation. Secondary salinization is the most common problem, so drainage facilities should be adequate whenever irrigation is practised. As the soils are calcareous, they require heavy and frequent applications of available phosphorus. Nitrogen is also needed annually.

Gd. Dystric Gleysols

These soils are acid and rather poor in nutrients. In addition, poor drainage makes them unsuitable for cultivation, and even pastures are not good. They occur mainly under the northern taiga forest of the western Siberian lowland in an association with Gleyic Podzoluvisols and Dystric Histosols in which they appear as a zonal feature. They are covered by rather open low forest near the forest tundra zone. It is unlikely that they will be cultivated in the near future.

Ge. Eutric Gleysols

These are fertile lowland soils which are widely cultivated despite poor drainage and gleying. They occur in river valleys of desert and semidesert areas of middle and central Asia, and often provide the only arable land available. The largest area of these soils is in the lower Yangtze valley and the Yangtze delta, China's most important rice granary. The lower Yangtze plain is traversed by countless canals, and in the southern part of the delta alone their total length amounts to about 35 000 km. These canals are used for navigation and for irrigation of paddy fields. In the delta are several polders that were created several centuries ago. Cotton and rice are the main crops of the area. Sericulture is also of importance. Of the winter crops, the most common are beans, maize, wheat, barley and sweet potatoes. Although these soils have a rather high natural fertility, chemical fertilizers are of primary importance for improved management. Equally important is the improvement of existing irrigation and drainage techniques. In the Yangtze valley these soils are seldom saline. In middle and central Asia they are often associated with Solonchaks, or are somewhat affected by salinization. Secondary salinization is a great problem under irrigation, and drainage is always necessary.

Gh. Humic Gleysols

Humic Gleysols characterize the depressions of the continent's temperate forest zone, where they are formed under the influence of a high ground water table. They occur mostly in the southern taiga subzone of Eutric Podzoluvisols under wet meadow and birch or aspen forest in the western Siberian lowland. They have a high humus content and nitrogen reserve, but are rather acid and have a low base saturation. Because of poor drainage and excess moisture, they are rarely cultivated and are mainly used for natural pasture and meadow. Among the many improvements that will have to be made to convert these soils into productive land is considerable drainage work.

Gm. Mollic Gleysols

Mollic Gleysols occur chiefly in river valleys in the Asian steppe zone, and in the lowlands of eastern Asia, where they occupy very large areas, especially in the Ussuri-Khanka plain, in Manchuria and in the north China and Yangtze plains. They have a good natural fertility and a favourable water regime, and have been preferred by farmers since ancient times. They are almost completely under cultivation. In the north China and Yangtze plains they represent the northern boundary of paddy cultivation, and further north are under cereals and cash crops. A slight salinity occurs frequently and must be checked.

Gx. Gelic Gleysols

These are the most extensive soils of northern Asia, characterizing the Asian tundra belt in both the lowlands and the mountains. The tundra soils have peculiar water and temperature regimes. They develop over the permafrost and vary according to its depth. Their excessive moisture is due to the impermeability of the permanently frozen ground below the surface. Cultivation is impossible because of the severe climate and unfavourable soil conditions. They can be used only for reindeer grazing.

I. Lithosols

These are the most common soils of the continent, characterizing the steep mountain areas in all natural zones. They can be associated with Gelic Gleysols and Gelic Regosols in the tundra belt, with Podzols, Podzoluvisols, Cambisols or Luvisols in the temperate forest belt, with Acrisols in the subtropics, with Chernozems and Kastanozems in the steppes, and with Xerosols and Yermosols in the deserts. Rock outcrops are frequent in all of these associations. Generally speaking, they are unsuitable for agriculture. However, in some favourable environments they are used for summer mountain pasture in association with other more suitable soils, e.g. in subalpine and alpine mountain belts where they occur in association with Humic Cambisols or Rankers. These soils are shallow and stony and are very susceptible to erosion where the natural vegetation has been disturbed.

J. Fluvisols

These are the soils of river valley flood plains. Owing to the small scale of the map, only large areas of Fluvisols can be shown, but they occur in almost all river valleys as inclusions in many soil associations.

They occur most frequently in association with various Gleysols, occupying somewhat better-drained positions along water courses. Calcaric Fluvisols occur chiefly in the deserts and semideserts and are often associated with Solonchaks. Dystric Fluvisols are limited to the northern part of the continent and do not cover large areas. Eutric Fluvisols occur in most of the river valleys. Their land use is most varied and closely related to climate and population density. In some regions they are the most intensively farmed soils, as for example in middle Asia or eastern China. In others, they are left under meadow for hay production.

In any case, Fluvisols are naturally fertile soils which can be utilized for many agricultural purposes. They are good for both cultivation and grazing. Under favourable climatic conditions and modern management, they are excellent soils for any crop. However, in some places work on river control is essential to guarantee good yields, and some fertilizers will probably be needed. If they are used for grazing, it will be necessary to improve the grass cover and introduce valuable fodder plants. These soils are especially valuable in extreme environmental conditions (e.g. desert or tundra), where they constitute the only agriculturally important land. In the temperate forest belt they are the most fertile soils, and great care is needed to preserve and maintain their natural qualities.

K. Kastanozems

When shown on the map as a major soil unit, Kastanozems occur in two very different sets of environmental conditions. First, they are shown with a phreatic phase and occur in depressions and on river terraces in dry and desert steppe zones. In such conditions they are the best soils of their area owing to the availability of moisture to plants, and are largely under cultivation (especially cereal crops). Second, they occur on mountain slopes together with Lithosols and rock outcrops in the dry steppe belt of the central Asian mountain systems. In this case they are rather dry and are utilized only for sheep and goat pasture.

Kh. Haplic Kastanozems

These soils occur in the dry steppe zone of middle and central Asia. In middle Asia and Kazakhstan they are usually sodic and rather calcareous, whereas in eastern Asia (Mongolia, northeastern China), they are non-sodic and only slightly calcareous. Solonchaks are usually associated with them in both areas. Solonetz are common associated soils in Kazakhstan. Mollic Gleysols and Kastanozems with a phreatic phase occur in depressions and river terraces. Generally these soils are widely utilized for both cultivation (mostly cereals) and grazing. In Kazakhstan and northeastern China wheat is the main crop. Large herds of sheep, horses, camels, goats and cattle graze on the steppes of Kazakhstan and Mongolia. Owing to the dryness of the climate, yields are usually low and unreliable, and droughts are common. Irrigation is the only way to modernize agriculture. In Kazakhstan larger irrigation projects are planned. Once water is available under modern management, the productivity of these soils will increase substantially.

Kl. Luvic Kastanozems

Luvic Kastanozems occur in association with Xerosols in the desert steppe zone of middle and central Asia. In Kazakhstan and middle Asia they are usually sodic and calcareous, whereas in Mongolia and northeastern China they are non-sodic and slightly calcareous. Solonchaks and Solonetz are common associated soils, especially in Kazakhstan. Mollic Gleysols and phreatic Kastanozems occur elsewhere in depressions and along river terraces. At present these soils are mostly used for grazing. Reliable cultivation is impossible without irrigation. Of course, some spring crops could be grown occasionally, producing poor yields, but that is not common. Vast areas lie idle or are used only occasionally for grazing. This is a semidesert area which can be fully utilized only if water is available, but water sources are rather scarce. Under irrigation these soils will produce a good crop, but secondary salinization and alkalinization could be a hazard and should be prevented with appropriate drainage facilities and chemical improvements.

L. Luvisols

Lc. Chromic Luvisols

Chromic Luvisols occur on the rolling plateaus of Shantung province in eastern China. They are derived from loess, various rocks or old alluvial deposits. They are also associated with Lithosols, and Cambisols in the hilly areas of the Shantung Peninsula.

These soils are good for agriculture; the main limitation is the topography. The principal crops are winter wheat and soybeans. In addition, maize, sweet potatoes, groundnuts, cotton and tobacco are grown. The Shantung area is also famous for its fruits (e.g. apples, pears, peaches), most of which are grown on Chromic Luvisols.

Crop yields depend largely on the amount and distribution of rainfall and the amount of fertilizer used by the farmers. Nitrogen is generally deficient and must be provided through large applications of compost supplemented by mineral fertilizers.

Lf. Ferric Luvisols

Ferric Luvisols occur in the hilly river valleys of southern China. Most are under cultivation, although some remain under forest. Topography is the main limitation to agriculture, but wherever it is favourable intensive subtropical agriculture flourishes. Paddy is commonly grown on hill slope terraces and on flat ground. Mango, orange and palm groves alternate with plantations of sugarcane, pineapple and banana, and at higher elevations tea grows in dense thickets. The soils are fairly fertile and well drained owing to the presence of iron concretions. Fertilizers, especially phosphorus and nitrogen, are needed under improved management. Soil erosion is a serious problem. The conservation practices needed depend on the gradient and length of the slope. The water supply is sufficient, but artificial drainage may be needed where the subsoil is heavy.

Lg. Gleyic Luvisols

Gleyic Luvisols occur widely in the Zeya-Bureya and Ussuri-Khanka plains. They are largely used for cultivation; wheat, soybeans, fodder crops and vegetables are the chief crops. Rice is grown in the warmer parts of the Ussuri-Khanka plain. Large meadows are used for grazing. Owing to a heavy subsoil, these soils are poorly drained. This situation is worsened by long winter freezing of the ground. The spring thaw comes late and the soil is saturated during the first part of the summer and early autumn. Hence appropriate drainage control is an essential element of improved management. Mineral and organic fertilizers are also necessary. Numerous crops can be grown, with good yields, under proper management. Grazing grounds are excellent and animal husbandry could flourish.

Lo. Orthic Luvisols

Orthic Luvisols occur widely in association with Lithosols in the Sikhote Alin, Lesser Khingan and northern Korean ranges. They are usually shallow and stony and characterize steep mountain slopes. They are almost completely under forest — the best possible land use in such conditions. The forest is of good quality and produces valuable timber. Erosion could become a problem if forest clearing progresses too extensively, and appropriate measures should be taken to prevent this.

Lp. Plinthic Luvisols

Plinthic Luvisols occur in association with Gleysols along the south coast of China and in the northern part of Hainan. They are found on the lower parts of slopes where the relief is rather dissected by ancient and present water erosion. Topography is the main limitation. Rice is the chief crop, and mango, palm and orange plantations are scattered among the paddy fields. Bananas, pineapples and sugarcane are also grown. Usually, two crops are grown annually, and three crops a year are not uncommon. Under improved management, Plinthic Luvisols need fertilizers. There is no water deficiency problem and no saturation, as these soils are well drained. However, when plinthite comes to the surface as a result of erosion, it forms hard pans, and the soil becomes bare and is abandoned. The only way to prevent the extension of such badlands with hard pans at the surface is to introduce strict erosion control.

M. Greyzems

Mg. Gleyic Greyzems

Gleyic Greyzems occur in the eastern Siberian forest-steppe in broad depressions at the transition from forest to steppe vegetation. As they occur within the permafrost zone, they are gleyed above the permafrost in the lower part of the profile. There are some swamps. Gelic Gleysols usually occur in association with these soils. The permafrost, above-permafrost gleying and poor drainage severely limit their utilization in agriculture, and climatic conditions are also unfavourable. A limited cultivation of quick-growing fodder crops, grasses, cereals, potatoes and vegetables is practised throughout the area. The meadows provide fodder for cattle. But even with improved management, cultivation is limited owing to the permafrost and unfavourable climate.

Mo. Orthic Greyzems

These soils characterize the forest-steppe zone of the western Siberian lowland. They also occur in association with Lithosols in the forest-steppe belt of all mountain systems transecting the continent along the 50th parallel from the Altai to the Greater Khingan mountains at the corresponding altitudes. In the western Siberian lowland they are mostly under cultivation and produce fairly good crops of cereals, sugar beet, peas, potatoes and fodder. For increased productivity, they should be heavily dressed with lime and mineral and organic fertilizers. Erosion control is also necessary. In the mountains they are commonly under forest which produces good timber — their best land use in such terrain.

O. Histosols

Histosols occur widely throughout the lowlands of northern and central Asia, but best characterize the tundra belt of northern Asia and the western Siberian lowland. These soils are scattered throughout the tundra area, and form, together with Gleysols, a complicated mosaic pattern. In the arctic tundra zone Eutric Histosols and Gelic Histosols predominate, whereas in the southern tundra and forest-tundra Dystric Histosols are more common. In the western Siberian lowland Histosols are dominant in soil associations occurring in river valleys and inter-hill depressions. Dystric Histosols predominate throughout the taiga forest belt, and Eutric Histosols are dominant in the swampy areas south of this forest zone. Very large areas of Siberian Histosols unsuitable for any land use are lying idle at present, but in the future they could be utilized for agriculture with good results under proper management after drainage. They are already utilized locally, but on a scale that is insignificant when their enormous total area is considered. Once brought under cultivation, their management will be rather expensive, as they will require a great deal of care. They will need not only drainage, but also good regulation of the water regime, as they could become too dry after draining. They will need mineral fertilizers with both macronutrients and micronutrients.

P. Podzols

Pg. Gleyic Podzols

Gleyic Podzols typically occur under the northern taiga coniferous forest of the western Siberian lowland, usually on sandy river terraces. In spite of the sandy substratum, the area is generally poorly drained owing to the flat topography. Dystric Gleysols are usually scattered among the Podzols. The soils are extremely acid and poor in nutrients. Very rarely are they under cultivation, and are mostly covered by virgin taiga forest. Under cultivation they produce rather low yields and need heavy fertilizer applications to be productive. All kinds of fertilizers are necessary, and drainage work is indispensable. Hence these soils are best kept under forest, although the forest stands they carry are not of good quality.

Ph. Humic Podzols

The Humic Podzols of the western Siberian lowland are also concentrated on sandy river terraces, but in the middle taiga subzone. These soils are very similar to the previous ones, with the exception of the drainage pattern. Generally they are better drained and are not gleyed from the top. They are also very acid and poor in nutrients. Although they are called " humic," this refers to the B horizon, and the humus content is low. Sometimes they are cultivated, but are mostly under pine forest. They also occur in the mountains in association with Lithosols, especially in the Far East region of the U.S.S.R., where they are completely under forest. Except in some particular situations, these soils should be kept under permanent forest cover.

Q. Arenosols

Qc. Cambic Arenosols

These sandy desert soils sometimes occur among shifting sand dunes. On the map they are shown only in a small area in the southern part of middle Asia in association with Yermosols and Solonchaks. They also probably occur in the large areas of shifting sands of the Kara Kum and Kyzyl Kum deserts of middle Asia, and in some parts of Dzungaria, Kashgaria and other deserts of central Asia, but this was not confirmed by existing information. Arenosols are sands stabilized by sparse vegetation, and have a very limited development. They could be utilized only for restricted grazing, for overgrazing will very quickly destroy the unstable surface and the sands will again become mobile. With water available for irrigation, some limited cultivation could be practised on the better ground. Without irrigation, only restricted grazing is possible.

R. Regosols

Rc. Calcaric Regosols

These soils occur in central and eastern Siberia in association with Gelic Cambisols and Gelic Gleysols. They may have a deep permafrost, and the soil profile is poorly developed and calcareous. They are mostly under forest, but in places some cultivation is practised. Climate is the main limiting factor; it is too cold for any large-scale agriculture, and only a restricted number of crops can be grown, e.g. some cereals, fodder grasses, potatoes and vegetables whose yields can be increased with application of fertilizers.

Rd. Dystric Regosols

Dystric Regosols occur on river terraces in the taiga belt of the western Siberian lowland. They are sandy, weakly developed soils under pine forest. They are well drained, moderately acid, but deeply leached and very poor in humus and nutrients. Cultivation of these soils is possible with heavy applications of fertilizers, but it is better to keep them under forest if there are better soils in the area.

Re. Eutric Regosols

These soils occur in association with Gleysols and Fluvisols in river valleys, and with Andosols on hill slopes. They are rather uncommon and limited in area. Their utilization depends mostly on the topography. In river valleys among Fluvisols or Gleysols they may be used for cultivation or for grazing. On hill slopes among Andosols they are mostly under forest and are very susceptible to erosion after deforestation.

Rx. Gelic Regosols

Gelic Regosols are undeveloped arctic and tundra soils with polygonal surfaces. Because of the climate they cannot be used in agriculture, and provide reindeer only the poorest of pasture. No improvement of land use of these soils can be advised at present.

S. Solonetz

Gleyic Solonetz, Mollic Solonetz and Orthic Solonetz occur as dominant soils in large parts of central Asia. They also occur broadly as associated soils or inclusions in steppe and desert formations in association with Chernozems, Kastanozems, Xerosols and Yermosols. They occupy rather large areas in the drier parts of the continent and sometimes spoil otherwise excellent arable lands, where they occur in small depressions on the plains. They vary in their morphological and agricultural properties and in the ways in which they can be improved. But as their most important features are the same, they will be treated together.

The most notable property of Solonetz soils is strong alkalinity, frequently combined with salinization of the subsoil. Hence chemical improvement is always needed to make them productive. Application of gypsum is usually recommended. Irrigation is required to eliminate the products of chemical reactions and to supply cultivated plants with available water. Adequate drainage is essential to protect them from secondary salinization and alkalinization. Grass sowing helps to increase their biological activity and improve their structure. The combination of all the above measures will make these soils suitable for cultivation. Otherwise, they will lie idle or, if cultivated, produce only a very poor crop. As Solonetz soils are usually heavy and have a slowly permeable subsoil, their improvement is always expensive and requires much time and labour.

T. Andosols

Andosols are the typical soils of the Kamchatka Peninsula and Japan, where they cover large areas, mainly on mountain slopes. Ochric Andosols and Vitric Andosols are the dominants, and Humic Andosols and Mollic Andosols occur only as associated or included soils in the areas dominated by them. Vitric Andosols occur mostly in lowlands such as the central Kamchatka valley or the Isikari lowland on the island of Hokkaido, whereas Ochric Andosols are more typical on mountain slopes. Among the other soils which occur in association with Andosols are Podzols, Podzoluvisols, Cambisols, Acrisols, Regosols, Lithosols, Gleysols and Histosols. This is quite understandable when account is taken of the nature of volcanic activity, the range of age of the volcanic materials, and the general geographical position of the region. Andosols are usually associated with Lithosols on mountain slopes, with Gleysols and Histosols in the lowlands, with Podzols and Podzoluvisols in the northern part of the region, and with Cambisols and Acrisols in the southern part. Thus, the soil pattern in the Andosol-dominated association is always very complex, and the complicated nature of the surface is intensified by the strong susceptibility to erosion of the volcanic materials. The surface is usually very rough and strongly dissected. Hence topography is often the main limitation to agriculture on Andosols. Most of these soils are under forest. In the agricultural areas erosion is active. In the Kamchatka Peninsula only the Vitric Andosols of the plains are cultivated. Wheat, oats, barley, potatoes, fodder crops and vegetables are grown on a small scale. In Japan a variety of crops (e.g. cereals, fruits, vegetables, flowers) can be grown, depending on the climatic conditions. The pastures and forests are good, as the plant nutrient content of Andosols is sufficient. These soils are frequently acid, and most crops need liming. Phosphorus and nitrogen fertilizers are also necessary.

U. Rankers

Rankers occur in northern and central Asia only as co-dominant soils together with Lithosols and Humic Cambisols in the alpine and subalpine belts of the high-mountain systems, mostly those in central Asia. Rankers and Humic Cambisols support the best high-mountain summer pasture — the only possible land use, and one which is widely practised. Some measures should be taken to improve the plant cover of this pasture.

V. Vertisols

Vp. Pellic Vertisols

Limited areas of Pellic Vertisols occur on heavy subrecent alluvial deposits in lowland areas of the Yangtze valley in eastern China. The topsoils are dark-coloured or nearly black at 30 to 60 cm depth, and crack open upon drying owing to their swelling clays. Self-mulching of fine-structured surface soils and the presence of slickensides with glossy surfaces in the subsoil are common characteristics. The clayey subsoil is usually slowly permeable and mottled. Lime concretions may be present. These soils are generally associated with Gleysols (mostly Mollic Gleysols). A wide range of crops, in particular rice, is grown on them.

Management of these soils is difficult owing to their heavy texture and swelling clays. Their permeability is very slow when wet, and their stickiness makes agricultural practices very difficult. Under well-adapted management, including use of moderate amounts of fertilizers (mainly N and P), good yields can be obtained.

W. Planosols

Ws. Solodic Planosols

These are apparently the only Planosols occurring in northern and central Asia. They occur in various natural zones, from forest-steppe to dry steppe and semidesert, usually in association with Gleysols and Solonetz. They never occupy large continuous areas, but are scattered among other soils in small closed depressions varying from several metres to several kilometres in diameter. Because of their level and low-lying position in the landscape and the presence of a heavy-textured impermeable B horizon, most of these Solodic Planosols are inundated part of the year. They are often left idle among tracts of arable land. Drainage may be constructed where conditions are favourable, but then some care should be exercised by farmers, as these soils are difficult to cultivate. They are acid from the surface, but alkaline in the subsoil. Fertilization is needed to produce good crops.

X. Xerosols

Xh. Haplic Xerosols

Haplic Xerosols occur chiefly in a narrow belt of foothills and plateaus along the northern slopes of the Tien Shan ranges in the piedmont desert steppe zone. Annual rainfall may reach 300 mm, making it less desertic in comparison to the deserts to the north. These soils are largely utilized for crop production under irrigation. Several fibre crops, sugar beets and tobacco are the main crops. Fruits and vegetables are also of importance, and fodder crops are produced for cattle. Under rainfed conditions, these soils are used for wheat and barley. Nitrogen and phosphorus fertilizers are required. Secondary salinization sometimes occurs in the region, and drainage systems to improve irrigation systems are being planned or are under construction.

Xk. Calcic Xerosols

Calcic Xerosols occur in the western Tien Shan, pre-Gissar and pre-Kopet Dag regions of the piedmont desert steppe zone of the middle Asian subtropics. These regions consist of the foothills and plateaus of the corresponding mountain ranges to the south and east, and are open to the desert on the north and west. These soils form the main agricultural regions of middle Asia: the Fergana valley, the Tashkent and Samarkand oases of Uzbekistan; the Dushanbe and Vakhsh oases of Tadzhikistan; the Ashkhabad oases of Turkmenia; the Turkestan region of Kazakhstan and the largest irrigation system of the Betpak-Dala. Almost all agriculture is practised under irrigation, and all is highly modernized. Cotton is the chief crop of the area, which produces more than half of the cotton grown in the U.S.S.R. As the main crop rotation in the cotton growing area is cotton-alfalfa, cattle production flourishes. Wheat is grown under rainfed conditions. Numerous fruits and vegetables are grown in other areas. The region consumes large quantities of mineral fertilizers, including nitrogen and phosphorus. Secondary salinization, a big problem in places, is controlled through drainage systems. The irrigated area is still being expanded, bringing new, highly productive land under cultivation.

Xl. Luvic Xerosols

These are the main soils of the vast desert steppes of middle and central Asia, and characterize the outskirts of the great deserts. In the Turan lowland they are mostly sodic and highly calcareous, while in Mongolia and China they are non-sodic and poor in carbonates. Solonchaks, and especially Solonetz, are common associated soils. As water is scarce in the regions where these soils occur, cultivation is concentrated along the river valleys. They are mostly used for poor pasture for sheep, goats, camels and horses. With irrigation they could be properly utilized, but there are few water sources. Pastures could be improved by introducing improved plant varieties. Under irrigation secondary salinization and alkalinization would be a problem, but could be controlled by drainage and good management.

Xy. Gypsic Xerosols

These soils are not shown as dominants on the map, but they occur in places among Luvic Xerosols. They are the poorest of the Xerosols and are very rarely cultivated. The main land use is pasture.

Y. Yermosols

The large areas of Yermosols shown on the map include both extremely arid and primitive desert soils, and phreatic Yermosols on river terraces. The former mostly lie idle, and the latter are partly utilized for cultivation or for pasture. With irrigation these soils can be used for different agricultural purposes, but without it no crop can be grown. Solonchaks are usually associated with these soils.

Yh. Haplic Yermosols

Haplic Yermosols occur in central Asian deserts such as the Aral-Balkhash region, Dzungaria, Kashgaria, the Turfan depression, the Gobi and the Tsaidam basin. They are usually poor in carbonates, frequently shallow and stony, and often alternate with rubbly desert surfaces, salt flats or shifting sands. Solonchaks are common. Because of the absence of water, these large areas lie idle and cannot be utilized. When water is available along the rare rivers or near wells, limited cultivation is sometimes possible. Oases are scattered over long distances. These are real desert regions which offer no possibility of development in the near future.

Yk. Calcic Yermosols

These soils are similar to Haplic Yermosols, but they are calcareous throughout. Calcic Yermosols occur in the Aral-Caspian desert region of the Turan plain, mainly in the Ust Urt plateau. Cultivation is impossible without irrigation. The soil cover is complex. Solonetz, Solonchaks, Gypsic Yermosols and Lithosols often occur as associated or included soils. Salt flats and shifting sands are common. These soils are often shallow and stony. Most of them are alkaline or saline. Sheep pasture is the only land use and will continue to be so for a long time, as water sources are insufficient for irrigation; they are just enough to provide water for sheep herds.

Yt. Takyric Yermosols

Takyric Yermosols occur mostly in the Turan plain, especially in the Kara Kum desert among shifting sand dunes. They characterize flat clay surfaces representing old dry river flats. They are usually associated with Solonchaks, and in places with salt flats. They are vegetationless and cannot be cultivated without irrigation. Wherever water is available for irrigation, they are used for a variety of crops, including cereals, cotton, alfalfa, vegetables and fruits. The heavy soil texture is a problem which can be solved by application of sand. Secondary salinization is prevented by appropriate drainage.

Yy. Gypsic Yermosols

Gypsic Yermosols do not occur as dominant soils in the deserts of northwestern China, but elsewhere they are frequently associated with Haplic Yermosols, or especially Calcic Yermosols. Poor sheep or camel pasture is the only land use possible without irrigation. With irrigation they can be cultivated, but construction and management of irrigation systems on gypsiferous soils are rather difficult and should be avoided if other soils are available nearby. In some places the gypsum layers are so thick and hard that they create additional problems for irrigation which cannot be easily solved.

Z. Solonchaks

Solonchaks occur widely in steppe and desert zones, and are found in other landscapes too. Specific forms of Solonchaks occur in the arctic wastes and in the high-mountain subnival belt, which is also desertic. Generally they characterize arid landscapes where surface evaporation is higher than precipitation. The appropriate pedo-geochemical conditions are also of importance, as salts are usually brought to the surface from the subsoil by the ascending ground water. The Solonchak soil units are somewhat characteristic for different landscapes. Gleyic Solonchaks occur mostly in river valleys and deltas, and in broad lake depressions where the ground water is near the surface. Takyric Solonchaks characterize clay desert flats. Orthic Solonchaks widely occur in desert steppes and deserts, and also along the sea coasts and the shores of inland seas. Mollic Solonchaks are specific to the southern part of the western Siberian lowland, where they occur in association with Mollic Solonetz. Various types of Solonchaks occur widely in association with different soils of arid areas.

Solonchaks are unsuitable for traditional agriculture, being too saline for the growth of ordinary crops. All agricultural utilization of these soils depends totally on the leaching of toxic salts through physical, biological and technical reclamation methods. Irrigation and leaching of Solonchaks are successful only if drainage facilities are good. Thus, when natural drainage is impeded or insufficient, an artificial drainage system is always a prerequisite for the reclamation of these soils. The reclamation of Solonchaks has been described so thoroughly elsewhere that it is not necessary to repeat it here. The practice is well known to the specialists in the countries and regions concerned, although the local natural conditions are sometimes unfavourable and may present complicated problems for soil reclamation specialists.

Miscellaneous land units

Shifting sands

This type of surface, shown on the map by an overprint, characterizes the deserts of middle and central Asia. Shifting sand dunes occur in the Kara

Kum, Kyzyl Kum, Takla Makan and Dzungarian deserts. In the Kara Kum and the Kyzyl Kum the sand surface is partially stabilized, but sheep and camels graze here, and the overgrazed areas where the sand blows shift with time. Although the whole area of these sand deserts is shown as uniform on the map, in reality the sands in a part of the area are partly or to a large extent stabilized, and the dominant soils are Regosols and Arenosols under a sparse desert vegetation; in other parts the sands have become loosened by overgrazing and are mobile. In time, the position will be reversed; sands which are now shifting will be stabilized by natural vegetation, and those which are stable and grazed at present will become shifting sands. As it is impossible to delineate these areas on a map of such small scale, they are shown together as shifting sands to stress their potential ability to shift under improper utilization. With necessary care, they can be used for sheep and camel grazing, but the pressure on the land should be kept within appropriate limits.

GLACIERS AND SNOW CAPS

These surfaces, shown on the map by an overprint, have no agricultural use.

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APPENDIX

MORPHOLOGICAL, CHEMICAL AND PHYSICAL PROPERTIES OF SOILS OF NORTH AND CENTRAL ASIA: DATA FROM SELECTED PROFILES[1]

In this Appendix data are presented on typical profiles representing some of the soil units shown on the map of North and Central Asia. The data were selected from publications and thus methods and representativeness vary greatly. The profiles were not sampled specifically to characterize the particular soil units, but were rather selected as more or less satisfactory examples of the various units within the limits of the data available. The information presented here merely illustrates typical properties of various units so that comparisons can be made. Naturally, the description and analyses of one or two profiles will not show the range of characteristics within such broad units, but they should help at least to understand the concepts of the units. With such a variety of sources there is of course considerable diversity in the information supplied, and care in interpretation is needed, especially with regard to uniformity of analytical method. All horizon designations have been adjusted to those defined in Volume I. For the particularities of the U.S.S.R. system of profile descriptions, reference should be made to *Soil Survey* (Academy of Sciences of the U.S.S.R., 1959).

[1] Most of the data on U.S.S.R. soils were selected from publications by E.V. Lobova.

LIST OF SOIL PROFILES

Symbol	Unit		Country	Page	Symbol	Unit		Country	Page
Ao	ACRISOL	Orthic	Japan	88	Kh		Haplic	U.S.S.R.	128
Bc	CAMBISOL	Chromic	U.S.S.R.	90	Kl		Luvic	U.S.S.R.	130
Bd		Dystric	Japan	92	Od	HISTOSOL	Dystric	Japan	132
Bf		Ferralic	Japan	94	Ph	PODZOL	Humic	U.S.S.R.	134
Bg		Gleyic	Japan	96	Ph		Humic	Japan	136
Bh		Humic	Japan	98	Rx	REGOSOL	Gelic	U.S.S.R.	138
Bx		Gelic	U.S.S.R.	100	Sm	SOLONETZ	Mollic	U.S.S.R.	140
C	CHERNOZEM		U.S.S.R.	102	So		Orthic	U.S.S.R.	142
Ch		Haplic	U.S.S.R.	104	Th	ANDOSOL	Humic	Japan	144
Ck		Calcic	U.S.S.R.	106	Xh	XEROSOL	Haplic	U.S.S.R.	146
De	PODZOLUVISOL	Eutric	U.S.S.R.	108	Xl		Luvic	U.S.S.R.	148
Dg		Gleyic	U.S.S.R.	110	Yh	YERMOSOL	Haplic	U.S.S.R.	150
Gc	GLEYSOL	Calcaric	U.S.S.R.	112	Yk		Calcic	U.S.S.R.	152
Gd		Dystric	Japan	114	Yk		Calcic	U.S.S.R.	154
Ge		Eutric	Japan	116	Yt		Takyric	U.S.S.R.	156
Gm		Mollic	U.S.S.R.	118	Zg	SOLONCHAK	Gleyic	U.S.S.R.	158
Gx		Gelic	U.S.S.R.	120	Zm		Mollic	U.S.S.R.	160
Jc	FLUVISOL	Calcaric	U.S.S.R.	122	Zo		Orthic	U.S.S.R.	162
Je		Eutric	Japan	124	Zt		Takyric	U.S.S.R.	164
Kh	KASTANOZEM	Haplic	U.S.S.R.	126					

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ORTHIC ACRISOL	**Ao**
Red soil	Japan
Y. Kamoshita, 1958	Profile 900-903, p. 32
Location	Arita, Takigun, Mie prefecture
Altitude	
Physiography	Top area of hilly land
Parent material	Diluvium
Vegetatio	Shrubs with pine
Climate	8.1c, humid warm continental

Profile description

A	**0-5 cm**	Brownish black clay loam with humus.
B1	**5-15 cm**	Dark yellowish brown clay loam.
B2	**15-35 cm**	Yellowish red clay loam with weathered gravel.
BC	**35+ cm**	Red clay with weathered gravel.

ORTHIC ACRISOL
Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100g
		H_2O	KCl	% C	% N	C/N	% OM	
A	0—5	4.6	4.0					68.0
B1	5—15	4.8	3.8					52.0
B2	15—35	4.9	3.8					64.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_3O_4	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
A	12.94	16.55	8.09	0.60	0.17	0.40	0.16	0.09	0.20	0.04
B1	13.43	17.81	9.01	0.06	0.17	0.28	0.18	0.10	0.17	0.03
B2	15.55	20.83	10.11	0.16	0.17	0.34	0.23	0.08	0.17	0.07

[1] Including Na_2CO_3 soluble SiO_2.

CHROMIC CAMBISOL	**Bc**
Cinnamonic typical soil	Uzbekistan, U.S.S.R.
M.A. Abdulaev, 1965	Profile 15, p. 107
Location	Aman-Kutan, Yul-Sai range
Altitude	1 575 m
Physiography	West-southwest mountain slope, 20 to 25% slope
Parent material	Granite eluvium
Vegetation	Semisavanna
Climate	3.71b, isohygrous warm continental desert

Profile description

A	**0-7 cm**	Brownish cinnamon medium loam; fine granular structure; friable; abundant roots; sharp boundary.
B1	**7-36 cm**	Cinnamon medium loam; fine subangular blocky structure; slightly hard; common roots; worm holes and crotovines; some granite rubble; diffuse boundary.
B2	**36-94 cm**	Light cinnamon medium loam; medium subangular blocky structure; slightly hard to friable; common roots; diffuse boundary.
C	**94+ cm**	Mottled bleached brownish rubble and granite boulders.

CHROMIC CAMBISOL
U.S.S.R.

Horizon	Depth cm	pH		Cation exchange me %								CaCO₃ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	H	
A	0—7			17.6	16.0	91	12.9	2.4	0.7		1.6	2.29
B1	15—25			15.0	13.7	91	11.6	1.8	0.3		1.3	1.95
B2	45—55			18.0	17.3	96	14.9	2.1	0.3		0.7	2.18
B2	75—85			17.7	17.7	100	15.4	2.2	0.1		0.0	2.12

Horizon	Sol. salts		Organic matter				Particle size analysis %					
			% C	% N	C/N	% OM	1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
A			3.3	0.31	10		13.8	15.0	33.6	13.0	15.4	9.1
B1			1.0	0.10	10		21.2	12.6	29.5	9.5	14.6	13.1
B2			0.7	0.08	9		24.7	15.9	24.8	7.8	11.9	14.9
B2							30.3	16.6	22.9	6.3	10.9	13.0

Horizon	Total analysis % (on ignited base)												
	SiO_2	R_2O_3	Fe_2O_3	FeO	MnO	Al_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5	$\frac{SiO_2}{R_2O_3}$
A	66.95	18.35	2.15	2.81	0.12	16.20	1.64	2.91	3.14	2.75	0.02	0.26	6.3
B1	65.69	20.25	2.07	2.71	0.12	18.18	1.51	2.80	2.98	2.65	0.00	0.25	5.7
B2	65.59	23.08	3.90	0.97	0.11	19.18	1.67	2.31	3.00	2.22	0.00	0.25	5.7
B2	63.97	24.16	4.31	0.84	0.12	19.85	1.57	2.03	3.15	2.53	0.02	0.25	4.7
C	79.44	11.09	0.71	0.51	0.01	10.38	0.36	0.46	5.86	1.62	0.00	0.08	12.6

DYSTRIC CAMBISOL	**Bd**
Greyish brown forest soil	Japan
Y. Kamoshita, 1958	Profile 313-316, p. 30
Location	Iizume, Kitatsugaru-gun, Aomori prefecture
Altitude	
Physiography	Hilly upland
Parent material	Diluvium
Vegetation	Larch forest
Climate	7.6b, humid cool temperate marine

Profile description

A	**0-15 cm**	Black to brownish black loam rich in humus; fine crumb structure.
B1	**15-45 cm**	Dark brown clay loam with some humus; moderate crumb structure.
B2	**45-105 cm**	Greyish brown clay loam; angular blocky structure; tubular.
C	**105+ cm**	Yellowish brown clay more compact than B2; angular blocky structure; tubular.

DYSTRIC CAMBISOL

Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100g
		H_2O	KCl	% C	% N	C/N	% OM	
A	0—15	5.5	4.3	4.6	0.3	15.3	7.8	6.0
B1	15—45	5.6	4.2	2.5	0.1	25.0	4.3	9.0
B2	45—105	5.7	4.4	1.3	0.1	13.0	2.2	4.0
C	105+	5.4	4.0	0.1	0.0		0.2	13.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
A	9.02	7.80	3.87	0.12	0.50	0.51	0.13	0.08	0.06	0.04
B1	8.22	9.27	3.97	0.10	0.33	0.44	0.12	0.07	0.04	0.02
B2	9.75	9.59	4.28	0.12	0.22	0.47	0.14	0.08	0.03	0.01
C	9.67	7.41	4.43	0.14	0.20	0.50	0.10	0.07	0.02	0.00

[1] Including Na_2CO_3 soluble SiO_2.

FERRALIC CAMBISOL	**Bf**
Terra rossa	Japan
Y. Kamoshita, 1958	Profile 800-802, p. 48
Location	Akasaka, Ibi-gun, Gifu prefecture
Altitude	
Physiography	Eroded limestone area (karrenfeld)
Parent material	Limestone
Vegetation	Pine forest
Climate	8.1c, humid warm continental

Profile description

A	**0-10 cm**	Brownish black clay loam rich in humus; crumb structure.
AB	**10-15 cm**	Dark brown clay loam with humus; crumb structure.
B	**15-120 cm**	Reddish brown clay loam; angular blocky structure.
C	**120+ cm**	Grey limestone hard rock.

FERRALIC CAMBISOL

Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100g
		H_2O	KCl	% C	% N	C/N	% OM	
A	0—10	6.6	6.0	2.6	0.2	12.0	4.4	0.0
AB	10—15	7.1	6.1	1.9	0.0		3.2	0.0
B	15—120	6.6	5.5	1.0	0.1	10.0	1.7	0.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
A	13.11	20.08	8.43		1.83	0.67	0.42			0.14
AB	12.17	17.16	8.39		0.90	0.69	0.40			0.07
B	14.36	21.53	10.19		0.66	0.43	0.47			0.07

[1] Including Na_2CO_3 soluble SiO_2.

GLEYIC CAMBISOL	**Bg**
Wet forest soil	Japan
Y. Kamoshita, 1958	Profile 1-4, p. 46
Location	Kariwano, Senhoku-gun, Akita prefecture
Altitude	
Physiography	Upland
Parent material	Diluvium
Vegetation	Cypress forest
Climate	8.2b, humid semiwarm continental

Profile description

A	**0-20 cm**	Brownish black humic soil; soft; granular structure.
AB	**20-50 cm**	Dark grey clay with humus; angular blocky structure.
B	**50-80 cm**	Light yellowish grey clay; angular blocky structure; tubular.
G	**80+ cm**	Light bluish grey clay with cloudy light brown mottles; plastic; compact.

GLEYIC CAMBISOL

Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100g
		H_2O	KCl	% C	% N	C/N	% OM	
A	0—20	5.1	4.2	14.3	0.8	17.9	24.3	7.0
AB	20—50	4.9	4.4	3.4	0.2	17.0	5.8	57.0
B	50—80	5.0	4.6	2.4	0.2	12.0	4.1	14.0
G	80+	4.9	3.9	0.9	0.1	9.0	1.5	118.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
A	8.54	8.42	3.20	0.16	0.61	0.78	0.24	0.13	0.18	0.09
AB	16.01	15.32	3.97	0.13	0.17	0.97	0.32	0.08	0.06	0.01
B	21.04	21.67	4.18	0.11	0.13	0.98	0.27	0.09	0.08	0.01
G	28.64	24.66	4.82	0.11	0.10	0.90	0.16	0.08	0.09	0.10

[1] Including Na_2CO_3 soluble SiO_2.

HUMIC CAMBISOL	**Bh**
Brown forest soil	Japan
Y. Kamoshita, 1958	Profile 13-15, p. 29
Location	Kinuta, Kitatama-gun, Tokyo
Altitude	
Physiography	Upland
Parent material	Diluvium
Vegetation	Cultivated field in a deciduous forest area
Climate	8.2b, humid semiwarm continental

Profile description

A	**0-60 cm**	Brownish black clay loam rich in humus; fine crumb structure.
B1	**60-85 cm**	Dark brown clay loam with humus; crumb to blocky structure.
B2	**85-160 cm**	Brown clay loam; subangular blocky structure.

HUMIC CAMBISOL

Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100g
		H_2O	KCl	% C	% N	C/N	% OM	
A	0—60	5.4	4.8	8.0	0.5	16.0	13.6	2.0
B1	60—85	6.1	5.3	5.8	0.4	14.5	9.9	1.0
B2	85—160	6.0	5.6	3.0	0.2	15.0	5.1	0.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_3O_4	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
A	12.60	14.96	11.07	0.35	1.14	1.83	0.08	0.14	0.26	0.36
B1	14.77	20.77	15.14	0.18	0.75	2.10	0.07	0.10	0.25	0.11
B2	16.88	23.81	17.68	0.26	0.62	2.33	0.10	0.07	0.22	0.03

[1] Including Na_2CO_3 soluble SiO_2.

GELIC CAMBISOL	**Bx**
Podbur	Eastern Sayan, U.S.S.R.
V.O. Targulian, 1971	Profile 95-55, p. 73
Location	Mount Peretolchin
Altitude	2 050 m
Physiography	Level top of the mountain
Parent material	Weathered basalt
Vegetation	Open coniferous forest
Climate	10.14, dry monsoon taiga

Profile description

OA	**0-9 cm**	Peaty raw humic layer; brown debris and loamy sandy fine earth are mixed with semidecomposed raw organic matter; abundant roots; sharp boundary.
AB	**9-25 cm**	Cinnamon brown light loam; structureless; many weathered basaltic debris; fewer roots; diffuse boundary.
B	**25-45 cm**	Brown debris; structureless; friable; light loamy fine earth forms skins and crusts on the debris particles; few roots; diffuse boundary.
BC	**45-80 cm**	Black-brown friable basaltic debris; little fine earth in form of crusts on the debris surfaces; an alternation of fresh (black) and weathered (brown from the surface) debris; dry permafrost from 80 cm; almost without ice.

GELIC CAMBISOL

U.S.S.R.

Horizon	Depth cm	pH		Cation exchange me %									CaCO₃ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
OA	0—9	5.0	4.1	60.7	42.6	70	28.5	14.1				18.1	
AB	10—15	5.2	4.6	18.8	10.9	53	8.2	2.7				7.9	
B	28—33	5.3	4.6	14.8	12.6	86	9.5	3.1				2.2	
BC	55—60	5.3	4.7	11.0	10.2	93	7.7	2.5				0.8	
BC	70—75				9.5		7.3	2.3					

Horizon	Sol. salts		Organic matter					Particle size analysis %					
			% C	% N	C/N	% OM	Ch. a./Cf. a.	1- 0.25	0.25-0.05	0.05-0.01	0.01-0.005	0.005-0.001	<0.001 mm
OA								6	65	15	3	3	5
AB						9.05		10	34	26	3	20	4
B						6.63		19	29	23	3	18	5
BC						6.01							
BC						7.20							

Horizon	Total analysis % (on ignited base)									$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{R_2O_3}$
	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	MnO	CaO	MgO	K_2O	Na_2O			
OA	44.45	22.23	2.54	12.47	0.21	7.22	5.14	1.26	1.38	3.4	9.5	2.3
AB	43.61	25.02	2.70	15.95	0.19	4.60	4.67	0.65	1.14	3.0	7.3	1.9
B	43.20	27.26	2.12	13.02		4.88	6.03	0.67	1.22	2.7	8.9	1.9
BC	43.51	26.41	2.00	12.18	0.25	5.46	6.10	0.81	1.47	2.8	9.6	2.0
BC	45.08	26.60	1.90	11.54	0.25	5.85	6.84	0.95	1.80	2.9	10.5	2.1
C	48.67	18.58	1.90	10.48	0.14	8.13	7.80	1.66	2.85	4.7	12.5	3.1

CHERNOZEM (phreatic)	C
Meadow-chernozemic soil	Kazakhstan, U.S.S.R.
Kazakh Academy of Sciences, 1958	Profile 62
Location	3 km northwest of Gulaevka
Altitude	
Physiography	Lowland with broad depressions
Parent material	Loess-like loam
Vegetation	Meadow steppe
Climate	9.73, semiarid cold continental steppe

Profile description

A1	**0-6 cm**	Dark brownish grey turf with some fine earth; friable; clear boundary.
A2	**6-11 cm**	Dark grey light loam; very fine granular to fine crumb structure; friable; abundant roots; diffuse boundary.
A3	**11-35 cm**	Dark brownish grey light loam; crumb structure; slightly compacted; few thin cracks; abundant roots; diffuse boundary.
AB	**35-65 cm**	Brownish grey heavy loam with light-coloured mottles; crumb to angular blocky structure; compact, hard; thin cracks; abundant roots; diffuse boundary.
B	**65-90 cm**	Greyish brown heavy loam with dark mottles; weak blocky structure; compact, hard; few white carbonate spots and few rust-coloured spots; clear boundary; few roots.
BC	**90-135 cm**	Yellowish brown heavy loam with dark mottles; almost structureless; less compacted; few roots; white carbonate spots; few sparkling gypsum crystals; few rust-coloured spots; diffuse boundary.
C	**135-180 cm**	Yellow wet clay; structureless; many grey and rust-coloured spots.

CHERNOZEM (phreatic)

U.S.S.R.

Horizon	Depth cm	pH		Organic matter				Cation exchange me/100 g							$CaCO_3$ %
		H_2O	KCl	% C	% N	C/N	% OM	CEC	TEB	Ca	Mg	Na	K	H	
A1	0—6	5.8		9.2	0.75	12.2	15.8			36.0	12.1	0.8			0.0
A2	6—11	6.0		7.1	0.56	12.6	12.2			24.8	5.3	0.5			0.0
A3	20—30	6.7		2.4	0.53	4.5	4.1			27.6	1.4	1.4			0.0
AB	40—50	7.2		1.7			2.9			16.7	3.8	2.4			5.2
B	70—80	8.0													12.3
BC	100—110	8.0													14.8
C	160—170	8.0													7.5

HAPLIC CHERNOZEM	**Ch**
Ordinary Chernozem	Kazakhstan, U.S.S.R.
Kazakh Academy of Sciences, 1958	Profile 450, p. 58
Location	4 km southwest of Smirnovski
Altitude	
Physiography	Slightly sloping plain
Parent material	Loess
Vegetation	Feather grass-fescue steppe
Climate	9.33, monsoon cold steppe

Profile description

A1	**0-18 cm**	Black heavy loam; fine crumb structure; slightly compacted; abundant roots; diffuse boundary.
A2	**18-28 cm**	Blackish grey heavy loam; crumb structure; slightly compacted; abundant roots; diffuse boundary.
AB	**28-52 cm**	Dark grey heavy loam with brownish grey mottles; slightly compacted; crumb structure; clear boundary with tongues.
B1	**52-75 cm**	Dark grey heavy loam with dark brown mottling; hard; medium to coarse subangular blocky structure; clear boundary with tongues.
B2	**75-96 cm**	Grey tongues on dark brown heavy loam; coarse subangular blocky structure; compact, hard; diffuse boundary.
BC	**96-132 cm**	Brown heavy loam with a few grey mottles; few whitish melting spots of carbonates; very coarse subangular blocky structure; diffuse boundary.
C1	**132-170 cm**	Yellowish brown clay; structureless; friable; white carbonate spots; diffuse boundary.
C2	**170-300 cm**	Yellowish brown heavy loam; structureless; white carbonate spots and sparkling gypsum crystals.

HAPLIC CHERNOZEM
U.S.S.R.

Horizon	Depth cm	pH		Organic matter					Cation exchange me/100 g							$CaCO_3$ %
		H_2O	KCl	% C	% N	C/N	% OM	Ch. a / Cf. a	CEC	TEB	Ca	Mg	Na	K	H	
A1	0—10	6.4		5.2	0.37	14.4	9.2	2.8			31.0	1.8	0.1			0.0
A2	18—28	6.5		3.5	0.31	12.3	6.6	3.2			25.6	5.4	0.1			0.1
AB	35—45	7.0		1.7	0.17	10.9	3.2	2.4			25.5	3.6	0.2			0.9
B1	55—65	8.9		1.5			2.6									3.9
B2	80—90	8.4		0.7			1.2									13.0
BC	110—120	8.6														14.5
C1	150—160	8.3														8.0
C2	190—200	8.1														6.3
C2	290—300	8.7														3.0

CALCIC CHERNOZEM	**Ck**
Southern Chernozem	Kazakhstan, U.S.S.R.
Kazakh Academy of Sciences, 1958	Profile 3
Location	5 km south of Evgenjevka, Tobolsk
Altitude	
Physiography	Slightly undulating plain
Parent material	Loess-like loam
Vegetation	Feather grass-fescue dry steppe
Climate	9.73, semiarid cold continental steppe

Profile description

A	**0-25 cm**	Dark brownish grey heavy loam; granular to fine crumb structure; slightly compact, slightly hard; numerous grass roots; diffuse boundary.
AB	**25-45 cm**	Dark greyish brown heavy loam; crumb structure; slightly compact; slightly hard; common roots; clear boundary with wide tongues.
B	**45-80 cm**	Brown heavy loam with dark grey mottles; subangular blocky structure; slightly compact, hard; a few white carbonate spots in the lower part; diffuse boundary.
BC	**80-120 cm**	Dark yellowish brown heavy loam with a few dark greyish brown and many white spots; slightly compact to friable; subangular to angular blocky structure; diffuse boundary.
C	**120-150 cm**	Yellowish brown heavy loam; structureless; slightly compact, slightly hard; numerous whitish carbonate spots.

CALCIC CHERNOZEM
U.S.S.R.

Horizon	Depth cm	pH		Organic matter				Cation exchange me/100 g							$CaCO_3$ %
		H_2O	KCl	% C	% N	C/N	% OM	CEC	TEB	Ca	Mg	Na	K	H	
A	0—20	7.0		3.0	0.24	12.5	5.2			19.0	3.0	0.1			0.0
AB	30—40	7.5		1.3	0.10	12.7	2.2			10.0	2.0	1.0			0.0
B	60—70	8.5		0.7	0.10	7.0	1.2			12.0	4.6	0.7			11.6
BC	100—110	9.2													8.6
C	140—150	8.2													2.0

EUTRIC PODZOLUVISOL	**De**
Derno-slightly podzolic soil	Central Siberia, U.S.S.R.
On soils of the Urals and western and central Siberia	Profile 42
Location	5 km from Suvorovoi along Ust-Kut-Zayarsk road, central Siberia
Altitude	
Physiography	Slope of a hill
Parent material	Sandstone eluvo-diluvium
Vegetation	Pine forest
Climate	10.19, steppe taiga

Profile description

O	**0-2 cm**	Leaf litter.
A	**2-7 cm**	Dark brown medium loam; weak medium crumb structure; friable; clear boundary.
E	**7-16 cm**	Light brown sandy loam; dusty-crumb structure; boundary with tongues.
EB	**16-24 cm**	Transition between E and B horizons consisting of the tongues of E horizon into dissected B.
B1	**24-39 cm**	Brown light loam; angular blocky structure; slightly compacted; bleached sand powdering on aggregate surfaces; sharp boundary.
B2	**39-60 cm**	Reddish brown heavy loam; angular blocky structure; very hard, compact; some sandstone particles occur.
C	**60-97 cm**	Reddish brown sandstone eluvium; continuous hard rock from 97 cm; sandstone is calcareous.

EUTRIC PODZOLUVISOL
U.S.S.R.

Horizon	Depth cm	pH		% OM	Cation exchange me/100 g						Particles < 0.001 mm %
		H_2O	KCl		CEC	TEB	SP	Ca	Mg	H	
O	0—2		6.4	17.1	31.9	31.1	98	20.2	10.9	0.8	
A	2—7		5.7	7.0	18.2	17.3	95	12.0	5.3	0.9	11
E	8—16		5.4	1.8	7.8	7.3	94	5.0	2.3	0.5	7
B1	25—30		4.9	0.6	6.8	6.5	94	4.1	2.4	0.3	10
B2	46—56		4.7	0.5	15.8						35
C	77—88		6.3		10.8						28

GLEYIC PODZOLUVISOL Dg

Derno-podzolic gleyic soil	Western Siberia, U.S.S.R.
On soils of the Urals and western and central Siberia	Profile 26
Location	Anziferovka valley
Altitude	160 m
Physiography	Flat watershed plain
Parent material	Clay moraine
Vegetation	Birch-pine forest
Climate	10.11, ever-humid taiga

Profile description

O	**0-2 cm**	Leaf litter.
A	**2-8 cm**	Brown clay; fine to medium crumb structure; abundant roots; clear boundary.
E	**8-27 cm**	Light grey clay; angular blocky structure with some platiness; sharp boundary with tongues.
Bg1	**27-60 cm**	Brown clay with a little grey mottling; coarse blocky to prismatic structure; diffuse boundary.
Bg2	**60-122 cm**	Dark brown clay with prominent grey and rust-coloured mottling; diffuse boundary.
Cg	**122-170 cm**	Brown clay with bleached grey and rust-coloured mottling.

GLEYIC PODZOLUVISOL

U.S.S.R.

Horizon	Depth cm	pH		% OM	Cation exchange me/100 g						Fe in HCl extract mg/100 g
		H_2O	KCl		CEC	TEB	SP	Ca	Mg	H	
O	0—2	6.7	6.2		86.8	85.3	98	72.3	13.0	1.5	0
A	2—6	6.1	5.0	23.1	38.4	37.8	98	29.4	8.4	0.6	11
E	8—13	5.6	4.2	5.2	20.8	19.2	92	15.6	3.6	1.6	26
E	18—22	5.6	3.8	1.6	16.5	14.7	89	11.9	2.8	1.8	26
Bg1	35—40	5.3	3.8	0.8	22.3	21.0	96	16.2	4.8	1.3	26
Bg1	55—60	5.3	3.9	0.8	27.4	26.5	97	20.7	5.8	0.9	31
Bg2	100—105	5.5	4.3	0.7	34.4	33.9	99	26.3	7.6	0.5	37
Cg	165—170	5.9	4.8	0.4	26.9	26.7	99	22.5	4.2	0.2	43

CALCARIC GLEYSOL	**Gc**
Meadow soil	Kirgizia, U.S.S.R.
A.M. Mamytov, 1963	Profile 373, p. 388
Location	3 km west of Kyzyl-Dehkan, At-Bashi valley, central Tien Shan
Altitude	
Physiography	Flat river terrace
Parent material	River alluvium
Vegetation	Meadow
Climate	3.71b, isohygrous warm continental desert
Ground water	100 cm

Profile description

A1	**0-11 cm**	Grey medium loam; granular structure; abundant roots; strong effervescence.
A2	**11-27 cm**	Greyish brown clay with grey mottles; granular to crumb structure; many roots; strong effervescence; tonguey boundary.
Bg1	**27-45 cm**	Grey clay; platy granular structure; very plastic; strong effervescence.
Bg2	**45-80 cm**	Light grey clay; granular structure; some roots, pebbles; strong effervescence.
G	**80-100 cm**	Dirty grey clay with grey and rust-coloured mottling; compact and sticky; some roots; strong effervescence.

CALCARIC GLEYSOL
U.S.S.R.

Horizon	Depth cm	pH H_2O	pH KCl	% OM	$CaCO_3$ %	CEC me/100 g	Particle size analysis % 1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
Al	0—15	9.00		3.67	22.2		13.45	3.33	23.67	11.73	13.60	7.94
A2	15—25	8.62		1.64	25.2		0.32	0.35	11.35	13.53	28.97	17.06
Bgl	30—40	8.60		1.60	25.2		0.42	2.10	7.45	13.32	26.45	27.30
Bg2	50—60	8.46		1.25	42.8		0.48	1.78	11.98	14.44	20.09	20.37

Horizon	Water extract analysis % TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na + K
Al	0.658	0.215	0.023	0.056	0.105	0.006	0.047	0.072
A2	0.125	0.060	0.004	0.008	0.024	0.008	0.007	0.017
Bgl	0.080	0.050	0.001	0.004	0.007	0.008	0.006	0.004
Bg2	0.104	0.049	0.002	0.006	0.010	0.010	0.006	0.004

DYSTRIC GLEYSOL	**Gd**
Meadow soil	Japan
Y. Kamoshita, 1958	Profile 304-306, p. 40
Location	Tsuchidaki, Nishitsugaru-gun, Aomori prefecture
Altitude	
Physiography	Lowland
Parent material	River alluvium
Vegetation	Rice paddy
Climate	7.6b, humid cool temperate marine

Profile description

A	**0-20 cm**	Dark blue clay.
G1	**20-60 cm**	Light blue clay with rust-coloured mottles.
G2	**60-200 cm**	Light blue clay, sandy in lower part.

DYSTRIC GLEYSOL
Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100 g
		H_2O	KCl	% C	% N	C/N	% OM	
A	0—20	5.3	3.7	3.6	0.3	12.0	6.1	22.0
G1	20—60	6.6	5.1	0.8	0.1	8.0	1.4	0.0
G2	60—200	6.0	4.8	0.5	0.0		0.9	0.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
A	14.58	6.55	4.57	0.11	0.56	1.33	0.11	0.15	0.06	0.08
G1	14.91	7.93	6.87	0.28	0.61	1.99	0.17	0.13	0.03	0.09
G2	15.63	8.47	4.69	0.26	0.61	2.13	0.19	0.11	0.03	0.05

[1] Including Na_2CO_3 soluble SiO_2.

EUTRIC GLEYSOL	**Ge**
Grey lowland soil	Japan
Y. Kamoshita, 1958	Profile 338-339, p. 41
Location	Inakadate, Minamitsugaru-gun, Aomori prefecture
Altitude	
Physiography	Lowland river terrace
Parent material	River alluvium
Vegetation	Rice paddy
Climate	7.6b, humid cool temperate marine

Profile description

A	**0-30 cm**	Grey clay.
G	**30-120 cm**	Grey clay; plastic; mottled throughout the horizon.

EUTRIC GLEYSOL

Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100 g
		H_2O	KCl	% C	% N	C/N	% OM	
A	0—30	5.8	4.5	2.3	0.2	11.5	3.9	1.0
G	30—120	6.3	5.0	0.4	0.0		0.7	0.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
A	17.16	5.08	4.03	0.10	0.59	0.43	0.06	0.15	0.05	0.06
G	17.60	9.76	5.00	0.13	0.82	0.87	0.12	0.25	0.03	0.03

[1] Including Na_2CO_3 soluble SiO_2.

MOLLIC GLEYSOL	**Gm**
Meadow soil	Kazakhstan, U.S.S.R.
Kazakh Academy of Sciences, 1958	Profile 63
Location	3 km from Gulaevka
Altitude	
Physiography	Depression in flat plain
Parent material	Loess-like loam
Vegetation	Grass meadow
Climate	3.71b, isohygrous warm continental desert
Ground water	At 250 cm, fresh

Profile description

A1	**0-6 cm**	Dark grey light loam with abundant grass roots; friable; fine crumb structure; diffuse boundary.
A2	**6-19 cm**	Grey light loam; fine crumb structure; abundant roots; friable; diffuse boundary.
AB	**19-42 cm**	Grey light loam with light greyish shade; weak crumb structure; friable; many roots; diffuse boundary.
B	**42-70 cm**	Light grey medium loam with dark mottles; coarse blocky structure; common rust-coloured spots; diffuse boundary.
BC	**70-94 cm**	Yellowish brown heavy loam with dark mottles; structureless; strongly compacted; many rust-coloured spots; diffuse boundary.
C1	**94-116 cm**	Yellowish brown heavy loam with grey and rust-coloured spots; structureless; diffuse boundary.
C2	**116-200 cm**	Yellowish brown heavy loam with grey, white and rust-coloured spots; structureless; sticky; compact.

MOLLIC GLEYSOL
U.S.S.R.

Horizon	Depth cm	pH		Organic matter				Cation exchange me/100 g							$CaCO_3$ %
		H_2O	KCl	% C	% N	C/N	% OM	CEC	TEB	Ca	Mg	Na	K	H	
A1	0—6	5.2		8.8	0.68	12.9	15.1			34.0	3.2	0.0			0.0
A2	6—12	5.8		3.1	0.34	9.0	5.3			12.8	0.3	0.2			0.0
AB	20—30	5.9		1.8	0.23	7.8	3.1			17.6	0.0	0.4			0.0
B	50—60	6.4		0.9			1.6			20.0	2.0	0.2			0.0
BC	70—80	6.8		0.6			1.1			19.2	0.9	0.4			7.3
C1	100—110	7.0													10.9
C2	140—150	7.2													18.2

GELIC GLEYSOL	**Gx**
Montane tundra soil	U.S.S.R.
On soils of the Urals and western and central Siberia	Profile 37-B
Location	Obe-Is range, Ural region
Altitude	475 m
Physiography	Level top of mountain
Parent material	Ferruginous quartzite
Vegetation	Moss-lichen tundra
Climate	10.2, humid tundra

Profile description

O	**0-15 cm**	Moss pillow.
A	**15-35 cm**	Dark brown loam; structureless; friable; abundant roots; stony; clear boundary.
G	**35-50 cm**	Pale grey loam; many rust-coloured spots; stony; sticky; permafrost from 50 cm.

GELIC GLEYSOL
U.S.S.R.

Horizon	Depth cm	pH		Organic matter				Cation exchange me/100 g							Particles < 0.001 mm %
		H_2O	KCl	% C	% N	C/N	% OM	CEC	TEB	SP	Ca	Mg	Al	H	
O	0—10	4.4		15.7	0.65	24.3	27.2	24.6	6.1	24.8	3.2	2.9	4.5	14.0	
A	20—25	4.4		5.6	0.54	10.4	9.7	20.7	1.1	53.1	0.7	0.4	3.6	16.0	22.7
G	40—45	5.0		1.2			2.0	4.2	0.7	16.7	0.3	0.4	1.4	2.1	18.7

CALCARIC FLUVISOL	**Jc**
Alluvial meadow soil	Kirgizia, U.S.S.R.
A.M. Mamytov, 1963	Profile 260, p. 387
Location	Confluence of the Tyuz-Ashu and Uzun Bulak rivers, central Tien Shan
Altitude	
Physiography	Floodland of the Tyuz-Ashu river
Parent material	Recent alluvium
Vegetation	Meadow
Climate	3.71b, isohygrous warm continental desert

Profile description

A	**0-15 cm**	Grey heavy loam; abundant roots; slightly compacted; cloudy to granular structure; earthworms are present; strong effervescence.
B1	**15-30 cm**	Grey heavy loam with rust-coloured mottles; almost structureless; abundant roots; slightly compacted; strong effervescence.
B2	**30-50 cm**	Grey clay with numerous rust-coloured mottles; some gravel occurs; cloudy platy structure; very few roots; slightly hard; strong effervescence.
C	**50-100 cm**	Grey clay with rust-coloured and grey mottles; structureless; horizontal stratification is visible; gravel occurs; strong effervescence.

CALCARIC FLUVISOL
U.S.S.R.

Horizon	Depth cm	pH		% OM	$CaCO_3$ %	CEC me/100 g	Particle size analysis %					
		H_2O	KCl				1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
A	0—15	8.45		2.52	22.0	18.92	0.89	1.27	29.58	16.87	18.95	14.17
B1	15—30	8.30		2.22	20.9	18.39	0.59	2.78	28.37	14.43	15.08	17.27
B2	35—45	8.37		2.14	34.2	16.37	0.54	11.30	24.88	11.66	13.97	14.73
C	70—80	8.30		1.14	9.0	16.30	0.43	1.63	37.59	12.97	15.73	19.80

Horizon	Water extract analysis %							
	TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na+K
A	0.105	0.045	0.001	0.009	0.009	0.001	0.025	0.038
B1	0.078	0.031	0.001	0.005	0.008	0.001	0.015	0.030
B2	0.086	0.050	0.002	0.002	0.010	0.001	0.008	0.034
C	0.056	0.029	0.002	0.004	0.005	0.001	0.009	0.028

EUTRIC FLUVISOL	**Je**
Brown lowland soil	Japan
Y. Kamoshita, 1958	Profile 330-331, p. 42
Location	Nakazato, Minamitsugaru-gun, Aomori prefecture
Altitude	
Physiography	Lowland first river terrace
Parent material	Recent river alluvium
Vegetation	Rice paddy
Climate	7.6b, humid cool temperate marine

Profile description

A	**0-20 cm**	Brownish black clay with gravel and humus.
BC	**20-120 cm**	Dark brow loam rich in gravel; angular blocky structure; somewhat mottled.

EUTRIC FLUVISOL
Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100 g
		H_2O	KCl	% C	% N	C/N	% OM	
A	0—20	5.5	4.6	6.7	0.5	13.4	11.4	1.0
BC	20—120	5.9	5.0	5.8	0.4	14.5	9.9	0.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
A	16.45	6.71	3.30	0.18	0.85	0.52	0.08	0.09	0.14	0.32
BC	8.03	10.79	8.14	0.22	0.59	0.62	0.07	0.09	0.12	0.17

[1] Including Na_2CO_3 soluble SiO_2.

HAPLIC KASTANOZEM	**Kh**
Dark chestnut soil	Kirgizia, U.S.S.R.
A.M. Mamytov, 1963	Profile 266, p. 150
Location	Kokkumber, At-Bashi valley, central Tien Shan
Altitude	
Physiography	Flat high river terrace
Parent material	Old alluvial-diluvial loam
Vegetation	Fescue-feather grass steppe
Climate	3.72a, Mediterranean semiwarm continental desert

Profile description

A	**0-15 cm**	Grey heavy loam with chestnut shade; granular structure; numerous roots and earthworms; slightly compacted.
AB	**15-25 cm**	Grey heavy loam; granular structure; numerous roots and earthworms; fungous mycelia; scattered stones.
B1	**25-45 cm**	Light grey medium loam; structureless; compact; scattered pebbles; roots; porous.
B2	**45-90 cm**	Pale medium loam; structureless; compact; pointed carbonate exclusions; scattered pebbles.
C	**90+ cm**	Gravelly loam.

HAPLIC KASTANOZEM

U.S.S.R.

Horizon	Depth cm	pH		Cation exchange me %							$CaCO_3$ %
		H_2O	KCl	CEC	TEB	SSP	Ca	Mg	K	Na	
A	0—15	8.17		31.0			26.8	2.1			2.1
AB	15—25	8.36		26.3			18.4	2.1			7.0
B1	30—40	8.08		20.3			10.3	2.2			20.5
B2	55—65	8.36		13.0			8.1	2.1			30.0

Horizon	Organic matter					Particle size analysis %					
	% C	% N	C/N	% OM	Ch. a / Cf. a	1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001
A	3.5	0.56	6.2	6.1	0.97	3.25	3.47	36.73	16.74	18.52	17.58
AB	2.7	0.37	7.3	4.8		3.04	5.03	35.27	10.50	17.24	18.09
B1	2.0	0.29	7.0	3.5		4.03	1.28	30.23	11.22	14.03	14.57
B2	1.1	0.13	7.7	1.9		6.01	8.75	26.08	8.43	9.74	12.66

Horizon	Water extract analysis %		
	TS	HCO_3'	OM
A	0.130	0.049	0.060
AB	0.114	0.042	0.050
B1	0.117	0.048	0.035
B2	0.130	0.047	0.032

Horizon	Total analysis % (on ignited base)							
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	P_2O_5	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{R_2O_3}$
A	62.16	16.98	5.92	8.53	2.90	0.28	3.66	2.71
AB	59.24	10.35	4.79	16.86	3.97	0.21	5.72	3.91
B1	47.38	20.01	4.60	18.35	4.43	0.28	2.37	1.93
B2	51.42	14.81	5.45	19.92	4.96		3.47	2.54

HAPLIC KASTANOZEM Kh

Chestnut soil	Kazakhstan, U.S.S.R.
Kazakh Academy of Sciences, 1958	Profile 448
Location	6 km from Lake Tentyaksor
Altitude	
Physiography	Flat lowland
Parent material	Loess
Vegetation	Feather grass-fescue steppe
Climate	3.72a, Mediterranean semiwarm continental desert

Profile description

A	**0-11 cm**	Greyish brown medium loam; weak fine to medium crumb structure; slightly compacted, porous; clear boundary.
AB	**11-32 cm**	Light greyish brown heavy loam; subangular blocky structure; compact; clear boundary.
B	**32-52 cm**	Brown heavy loam; coarse subangular blocky structure; compact; white carbonate spots and veins; few roots; clear boundary.
BC	**52-85 cm**	Light brown heavy loam; coarse angular to subangular blocky structure; strongly compacted; white carbonate spots and veins; very few roots; diffuse boundary.
C1	**85-112 cm**	Brown heavy loam; blocky structure; very strongly compacted; white carbonate spots and veins; white sparkling gypsum veins.
C2	**112-150 cm**	Yellowish brown heavy loam; structureless; white spots and veins of carbonates and gypsum.

HAPLIC KASTANOZEM

U.S.S.R.

Horizon	Depth cm	pH		Organic matter				Cation exchange me/100 g							CaCO$_3$ %
		H_2O	KCl	% C	% N	C/N	% M	CEC	TEB	Ca	Mg	Na	K	H	
A	0—10			1.2	0.15	8.1	2.1			11.8	2.0	0.1			0.0
AB	15—25			0.9	0.12	7.2	1.5			18.7	3.9	0.1			1.5
B	35—45			0.6			1.1			11.8	3.9	0.1			6.6
BC	60—70			0.3			0.6								6.6
C1	90—100														5.5
C2	140—150														6.4

LUVIC KASTANOZEM	**Kl**
Light chestnut soil	Kirgizia, U.S.S.R.
A.M. Mamytov, 1963	Profile 7, p. 130
Location	Tasma range along Przhevalsk highway, central Tien Shan
Altitude	2 000 m
Physiography	Flat bottom of a depression
Parent material	Loess-like loam
Vegetation	Dry steppe
Climate	3.72a, Mediterranean semiwarm continental desert

Profile description

A	**0-20 cm**	Brownish grey light loam; dusty-crumb weak structure; strong effervescence from the surface.
AB	**20-32 cm**	Brownish grey loam; weak crumb structure; hard; weakly cracked; many roots few small white carbonate points.
B1	**32-49 cm**	Pale brownish loam with grey shade; weak fine crumb structure; friable; carbonate veins.
B2	**49-72 cm**	Pale brownish loess-like loam; dusty; rare veins of carbonates.
B3	**72-105 cm**	Pale brownish loess-like loam; structureless; less compacted; porous; no gypsum and carbonate exclusions.
C1	**105-120 cm**	Pale brownish loess-like loam; structureless; many gypsum crystals as nests or druses.
C2	**120-135 cm**	Pale loess-like loam; veins and small druses of gypsum.

LUVIC KASTANOZEM

U.S.S.R.

Horizon	Depth cm	H_2O	Organic matter				$CaCO_3$ %	Particle size analysis %					
			% C	% N	C/N	% OM		1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
A	0—15	8.2	2.13	0.30	7.1	4.16	7.9	1.48	4.85	38.66	12.07	16.06	18.64
AB	20—30	8.2	1.74	0.20	8.7	3.00	9.8	0.88	5.91	36.22	8.84	16.82	17.48
B1	35—45	8.2	1.57	0.19	8.3	2.96	13.4	1.08	7.55	33.92	11.85	14.66	17.59
B2	55—65	8.5	0.41	0.10	4.1	0.75	19.8	0.54	11.66	33.38	8.76	13.82	11.31
B3	80—90	8.4	0.40	0.09	4.4	0.66	15.9	0.19	4.04	31.94	8.57	11.15	18.05
C1	108—118	8.4	0.24			0.42	12.5	0.22	8.07	37.54	6.54	9.85	17.15
C2	120—130	8.4	0.22			0.38	14.1	0.11	0.19	43.60	8.47	9.12	11.07

Horizon	Water extract analysis %							
	TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na+K
A	0.094	0.054	0.000	0.002	0.006	0.010	0.004	0.003
AB	0.080	0.035	0.000	0.002	0.011	0.009	0.002	0.003
B1	0.080	0.034	0.000	0.003	0.017	0.010	0.003	0.001
B2	0.092	0.032	0.000	0.003	0.027	0.010	0.004	0.005
B3	1.232	0.018	0.000	0.005	0.813	0.260	0.044	0.016
C1	0.780	0.020	0.000	0.016	0.470	0.087	0.030	0.080
C2	0.768	0.020	0.000	0.032	0.432	0.052	0.032	0.109

DYSTRIC HISTOSOL	**Od**
Bog soil	Japan
Y. Kamoshita, 1958	Profile 707-708, p. 38
Location	Uranodate, Kamikita-gun, Aomori prefecture
Altitude	
Physiography	Bog area
Parent material	Lacustrine deposit
Vegetation	Reeds
Climate	7.6b, humid cool temperate marine

Profile description

O1	**0-10 cm**	Black clay rich in humus, with peat.
O2	**10-150 cm**	Brown peat.

DYSTRIC HISTOSOL

Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100 g
		H_2O	KCl	% C	% N	C/N	% OM	
O1	0—10	4.7	3.7	48.1	2.1	22.9	81.8	31.0
O2	10—150	4.6	3.9	54.1	2.3	23.5	91.9	16.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_3O_4	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
O1	3.63	3.42	0.98	0.18	1.24	0.37	0.08	0.14	0.34	0.22
O2	1.89	3.32	0.53	0.21	0.85	0.34	0.06	0.12	0.37	0.21

[1] Including Na_2CO_3 soluble SiO_2.

HUMIC PODZOL	**Ph**
Podzolic soil	Eastern Siberia, U.S.S.R.
V.O. Targulian, 1971	Profile 58-58, p. 142
Location	Cherni Ognit-Pravaya Medeka watershed
Altitude	1 340 m
Physiography	Flat top of mountain range
Parent material	Granito-gneiss
Vegetation	Northern taiga pine forest
Climate	10.19, steppe taiga

Profile description

O1	**0-10 cm**	Brown, weakly decomposed litter of leaves, needles and mosses with abundant roots.
O2	**10-14 cm**	Cinnamon brown peaty leaf litter with abundant roots; sharp boundary.
E	**14-23 cm**	Bleached grey medium loam with bleached mottles; stony; thin platy structure; numerous roots; clear tonguey boundary.
Bh	**23-36 cm**	Reddish brown medium loam with coffee-cinnamon mottles; stony; fine angular blocky structure; red skins on stones and aggregates; diffuse boundary.
B2	**36-58 cm**	Brown medium loam; fine angular blocky structure; stony; boulders; upper surface of boulders is covered by fine clay earth, lower by iron skins; diffuse boundary.
BC	**58-102 cm**	Brown rubble with little fine earth between boulders and stones.

HUMIC PODZOL
U.S.S.R.

Horizon	Depth cm	pH		Cation exchange me/100 g									$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
O1	0—10	4.7	3.6								5.8		
O2	10—14	3.7	2.6								10.9	47.0	
E	14—23	3.8	2.9	16.1	2.5	16	2.0	0.5			5.6	8.0	
Bh	24—34	4.4	3.6	17.0	1.6	9	1.2	0.4			5.3	10.1	
B2	42—52	4.8	4.1	6.8	0.7	10	0.5	0.2			4.0	2.1	
BC	67—72	4.8	4.0	5.8	1.4	25	0.9	0.5			3.7	0.7	
BC	90—100	4.9	4.0	5.8	1.6	28	1.2	0.4			3.6	0.6	

Horizon	Organic matter					Particle size analysis %					
	% C	% N	C/N	% OM	Ch. a / Cf. a	1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
E	2.87	0.20	14	4.22	0.4	14	20	26	8	14	17
Bh	2.92	0.22	13	4.62	0.1	15	21	24	5	18	16
B2				1.95		15	21	22	8	16	17
BC				1.10		15	19	27	9	15	14
BC				0.95		18	18	23	7	16	16

Horizon	Total analysis % (on ignited base)									$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{R_2O_3}$
	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	MnO	CaO	MgO	K_2O	Na_2O			
O1	60.68	9.91		2.16	0.47	5.84	1.67	5.90	4.58	10.8	80	9.8
O2	65.57	16.35		6.66	0.19	2.85	1.34	3.18	1.78	6.7	26	5.3
E	69.52	18.14	0.68	4.02	0.07	2.60	1.37	2.11	1.58	6.5	46	5.8
Bh	59.17	19.25	0.53	12.52	0.07	2.85	1.80	1.85	1.44	5.2	12	3.6
B2	61.32	20.74	0.49	8.34	0.09	2.66	2.80	2.04	1.53	5.0	20	3.9
BC	62.03	19.60	0.51	8.16	0.12	3.11	2.93	2.26	1.73	5.4	20	4.2
BC	61.97	19.32	0.58	7.97	0.13	2.67	2.86	2.36	1.78	5.5	20	4.2
C	69.12	17.18	0.44	5.06	0.14	2.36	0.48	2.09	2.49	5.9	43	4.9

HUMIC PODZOL Ph

Podzol	Japan
Y. Kamoshita, 1958	Profile 381-385, p. 25
Location	Yokohama, Shimokita-gun, Aomori prefecture
Altitude	
Physiography	River terrace
Parent material	Weathered volcanic ash material of Tertiary formation
Vegetation	Pine forest
Climate	7.6b, humid cool temperate marine

Profile description

A	**0-10 cm**	Brownish black clay loam; platy structure; rich in humus.
E	**10-15 cm**	Greyish white silty clay loam; non-plastic; structureless.
B1	**15-30 cm**	Dark brown clay loam; medium angular blocky structure; some humus and iron concretions.
B2	**30-60 cm**	Greyish brown clay loam; medium angular blocky structure; roots; accumulations of humus and iron.
C	**60+ cm**	Brown clay loam; angular blocky structure.

HUMIC PODZOL
Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100 g
		H_2O	KCl	% C	% N	C/N	% OM	
A	0—10	3.9	3.1	33.5	1.0	33.5	57.0	16.0
E	10—15	4.1	3.4	9.3	0.2	46.5	15.8	63.0
B1	15—30	4.4	3.6	14.0	0.3	43.3	23.8	105.0
B2	30—60	4.8	4.2	7.6	0.2	38.0	12.9	15.0
C	60+	4.9	4.5	2.5	0.1	25.0	4.3	4.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_2O_3	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
A	3.61	1.52	1.99	0.15	0.19	0.24	0.11	0.24	0.21	
E	1.97	0.49	1.96	0.10	0.22	0.07	0.06	0.08	0.04	
B1	3.61	2.56	7.41	0.09	0.30	0.28	0.10	0.08	0.08	
B2	10.72	15.90	7.80	0.13	0.44	0.66	0.12	0.10	0.11	
C	18.09	19.03	8.85	0.21	0.39	1.20	0.22	0.13	0.37	

[1] Including Na_2CO_3 soluble SiO_2.

GELIC REGOSOL	**Rx**
Podbur	Northern Siberia, U.S.S.R.
V.O. Targulian, 1971	3 to 4 km south of Stannah-Hocho
Altitude	70-100 m
Physiography	Flat surface of a hill on hilly plain
Parent material	Sand (sandstone eluvium)
Vegetation	Semishrub moss-lichen tundra
Climate	10.2, humid tundra

Profile description

O	**0-3 cm**	Green moss-lichen pillows with some leaf litter from semishrubs.
A	**3-6 cm**	Dark grey loamy sand; structureless; friable; abundant roots; clear boundary.
AB	**6-14 cm**	Dark greyish brown loamy sand; structureless; friable; few roots; separate sandstone rubble; clear boundary.
B	**14-45 cm**	Brown loamy sand with greyish brown mottles; structureless; friable; few roots; a little sandstone rubble; diffuse boundary.
BC	**45-60 cm**	Light brown sand; structureless; friable; frozen from 55 cm; few pieces of ice; non-stable and non-cemented.

GELIC REGOSOL
U.S.S.R.

Horizon	Depth cm	pH		Cation exchange me/100 g									CaCO$_3$ %
		H$_2$O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	Al	H	
A	3—6	5.5	4.2	17.3	14.1	82	10.4	3.7				3.2	
AB	6—12	5.1	3.8	13.5	9.6	71	6.7	1.9			0.7	3.9	
B	15—25	5.0	3.7	10.7	7.7	72	5.9	1.8			2.1	3.0	
B	40—45	5.1	3.8	10.1	8.1	80	6.4	1.7			0.6	2.0	
BC	55—60	5.0	3.8	11.0	8.9	81	6.3	2.6			0.6	2.1	

Horizon	Organic matter					Particle size analysis %					
	% C	% N	C/N	% OM	Ch. a / Cf. a	1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
A				6.24		26	33	21	2	6	9
AB	2.83	0.31	9	4.86	0.7	33	24	19	6	8	9
B	0.79	0.06	13	1.35	0.3	41	31	10	1	8	6
B	0.65	0.04	16	1.11	0.2	32	38	10	1	7	7
BC	0.81	0.06	14	1.39	0.3	38	36	12	1	3	6

Horizon	Total analysis % (on ignited base)									$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{R_2O_3}$
	SiO$_2$	Al$_2$O$_3$	Fe$_2$O$_3$	MnO	CaO	MgO	K$_2$O	Na$_2$O	SO$_3$			
A	72.64	13.03	6.12		1.89	1.97	1.18	1.84		9.5	32	7.3
AB	73.20	12.36	5.54		1.60	1.31	2.17	2.57		10.1	35	7.8
B	74.28	13.10	5.59		1.49	1.46	1.75	2.35		9.7	35	7.6
B	74.23	14.26	3.54		1.64	1.09	1.97	2.49		8.9	56	7.7
BC	74.02	14.59	2.97		1.60	1.29	2.11	2.74		8.6	69	7.7

MOLLIC SOLONETZ	**Sm**
Meadow-sierozemic Solonetz	Kirgizia, U.S.S.R.
A.N. Rozanov, 1959	Profile 29, p. 116
Location	14 km northwest of Kara-Balty, Chu valley
Altitude	< 900 m
Physiography	Lower piedmont plain
Parent material	Loess-like loam
Vegetation	*Campharesma-Artemisia* meadow steppe
Climate	3.71b, isohygrous warm continental desert

Profile description

AE	**0-12 cm**	Light grey silt loam; very thin platy structure above and medium subangular blocky structure below; cracky; many roots; clear boundary.
AB	**12-21 cm**	Greyish brown clay; angular to subangular structure; cracky; hard; clay skins on aggregates; clear boundary.
B1	**21-40 cm**	Light brown or cinnamon heavy clay; medium to coarse angular blocky structure; very compact; clay skins on aggregates; cracky; diffuse boundary.
B2	**40-60 cm**	Chocolate brown heavy clay with grey shade; coarse subangular blocky structure; very hard and compact; clay skins on aggregates; clear boundary.
B3	**60-76 cm**	Light grey loam with grey shade and brown mottles; small carbonate concretions.
C1	**76-111 cm**	Pale light silt loam with rust-ochre mottles; many carbonate concretions.
C2	**111-148 cm**	Pale light silt loam with numerous rust-ochre mottles and bands; fewer carbonate concretions.
C3	**148-190 cm**	Pale light loam with grey shade; numerous carbonate concretions and rust-brown mottles; very hard; very coarse blocky structure.

MOLLIC SOLONETZ
U.S.S.R.

Horizon	Depth cm	pH		Cation exchange me/100 g						$CaCO_3$ %
		H_2O	KCl	CEC	SSP	Ca	Mg	K	Na	
AE	0—10			7.42	9.6	5.00	0.75	0.96	0.71	5.10
AB	14—19			9.70	64.6	0.12	0.41	2.90	6.27	11.39
B1	25—35			10.14	54.6	0.12	0.48	4.00	5.54	25.57
B2	45—55									28.71
C1	85—95									35.72
C2	115—125									
C3	189—190									

Horizon	Organic matter					Particle size analysis %				
	% C	% N	C/N	% OM	Ch. a / Cf. a	2–0.25	0.25–0.02	0.02–0.002	0.002–0.0002	< 0.0002 mm
AE	1.59			2.73		6.74	38.76	39.40	13.09	1.71
AB	0.62			1.07		3.98	38.11	36.20	17.85	5.75
B1	0.56			0.96		2.29	48.10	20.80	29.02	4.58
B2	0.46			0.77		1.64	17.81	38.65	38.87	2.98
C1										
C2										
C3										

Horizon	Water extract analysis %											5 % KOH extr. analysis %	
	TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na+K	SiO_2	R_2O	OM	SiO_2	Al_2O_3
AE	0.194	0.090	0.000	0.052	0.020	0.005	0.001	0.069	0.022	0.005	0.016	2.36	0.28
AB	0.621	0.320	0.000	0.049	0.097	0.012	0.003	0.180	0.068	0.016	0.020	1.64	0.27
B1	0.836	0.450	0.000	0.043	0.187	0.005	0.001	0.279	0.020	0.012	0.017	0.66	0.07
B2	0.933	0.430	0.024	0.046	0.232	0.011	0.002	0.288	0.043	0.022	0.010		
C1	0.217	0.156	0.016	0.006	0.081	0.005	0.002	0.068					
C2	0.117	0.112	0.014	0.003	0.026	0.006	0.003	0.050					
C3	0.080	0.056	0.000	0.004	0.011	0.007	0.003	0.017					

Horizon	Total analysis % (on ignited carbonateless base)									$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{R_2O_3}$
	SiO_2	Al_2O_3	Fe_2O_3	P_2O_5	TiO_2	CaO	MgO	K_2O	Na_2O		
AE	66.01	14.30	7.85	0.24	0.56	3.86	2.62	2.12	1.63	7.9	5.8
AB	63.68	15.94	7.60	0.24	0.55	3.83	2.47	2.59	2.37	6.8	5.2
B1	59.21	15.62	8.63	0.12	0.74	5.86	4.46	2.62	2.12	5.4	4.8
C2	66.84	14.44	6.69	0.15	0.60	4.91	2.04	2.49	2.75	7.9	6.0

ORTHIC SOLONETZ	**So**
Steppe Solonetz	Kazakhstan, U.S.S.R.
Kazakh Academy of Sciences, 1958	Profile 317
Location	4 km west of Kabyrga river along the road to Bestau
Altitude	
Physiography	Depression in rolling to hilly plain
Parent material	Diluvium from Tertiary rocks
Vegetation	*Artemisia* steppe
Climate	3.71b, isohygrous warm continental desert

Profile description

A	**0-10 cm**	Grey light loam; very fine to medium crumb structure with some platy aggregates; friable; sharp boundary.
B1	**10-25 cm**	Greyish brown heavy loam; coarse columnar structure; very hard, strongly compacted; diffuse boundary.
B2	**25-50 cm**	Yellowish brown heavy loam; coarse prismatic structure; very hard, strongly compacted; white carbonate spots and veins; diffuse boundary.
BC	**50-80 cm**	Yellowish brown heavy loam; structureless; hard, compact; white carbonate spots and veins; diffuse boundary.
C	**80-120 cm**	Yellowish brown clay; structureless; hard, compact; white carbonate spots and veins; sparkling gypsum crystals.

ORTHIC SOLONETZ
U.S.S.R.

Horizon	Depth cm	pH		Organic matter				Cation exchange me/100 g						$CaCO_3$ %	$CaSO_4 \cdot 2H_2O$ %
		H_2O	KCl	% C	% N	C/N	% OM	CEC	TEB	Ca	Mg	Na	K		
A	0—10	6.5		0.5			0.9			6.8	0.0	0.2		0.0	0.0
B1	15—25	8.4		1.0			1.8			8.4	10.3	11.0		0.0	0.0
B2	30—40	9.0		0.3			0.6			5.0	4.9	4.7		10.5	0.0
BC	60—70	8.7								2.1	2.7	1.8		5.2	1.1
C	90—100	8.2												0.1	10.0

HUMIC ANDOSOL	**Th**
Recent volcanic ash soil	Japan
Y. Kamoshita, 1958	Profile 2-6, p. 50
Location	Uwa, Higashi Uwa-gun, Ehime prefecture
Altitude	
Physiography	Upland
Parent material	Diluvium
Vegetation	Cypress forest
Climate	8.2b, humid semiwarm continental

Profile description

A	**0-10 cm**	Brownish black humus soil.
AB	**10-14 cm**	Black clay loam.
C	**14-50 cm**	Yellowish brown loam; tubular; ashy.
D1	**50-85 cm**	Dark brown clay loam with gravel.
D2	**85+ cm**	Light brown clay loam with gravel; angular blocky structure.

HUMIC ANDOSOL

Japan

Horizon	Depth cm	pH		Organic matter				Exchange acidity me/100 g
		H_2O	KCl	% C	% N	C/N	% OM	
AB	10—14	5.7	5.5	11.5	0.5	2.30	19.6	7.0
C	14—50	6.2	6.3	1.0	0.0		1.7	0.0
D1	50—85	5.8	5.1	1.5	0.0		2.6	51.0
D2	85+	5.8	4.9	0.4	0.0		0.7	51.0

Horizon	Conc. HCl extracted, on dry basis %									
	[1] SiO_2	Al_2O_3	Fe_2O_3	Mn_3O_4	CaO	MgO	K_2O	Na_2O	SO_3	P_2O_5
AB	9.17	12.15	5.08	0.29	0.33	0.44	0.13	0.13	0.22	0.14
C	10.04	15.23	4.67	0.13	0.34	0.31	0.09	0.20	0.33	0.03
D1	10.74	9.81	5.88	0.43	0.27	0.79	0.30	0.17	0.04	0.04
D2	13.44	14.59	7.52	0.27	0.23	1.02	0.45	0.20	0.08	0.02

[1] Including Na_2CO_3 soluble SiO_2.

HAPLIC XEROSOL	**Xh**
Sierozem poor in carbonates	Kazakhstan, U.S.S.R.
I.A. Assing, 1965	Profile 21, p. 132
Location	Piedmont of Kirgiz range
Altitude	620 m
Physiography	Piedmont plain
Parent material	Loess-like loam on gravel
Vegetation	Dry semishrub steppe
Climate	3.71b, isohygrous warm continental desert

Profile description

A	**0-5 cm**	Light grey light loamy porous surface crust of very thin platy structure; sharp boundary.
AB	**5-30 cm**	Brownish light grey medium loam with unstable medium subangular blocky structure; slightly hard, friable; sharp boundary.
B	**30-118 cm**	Pale heavy loam; coarse subangular blocky structure; very hard, compact; strong effervescence; sharp boundary.
C	**118+ cm**	Pale yellow light loess-like loam.

HAPLIC XEROSOL
U.S.S.R.

Horizon	Depth cm	pH		Cation exchange me/100 g							$CaCO_3$ %
		H_2O	KCl	CEC	TEB	% BS	Ca	Mg	K	Na	
A	0—5						7.3	1.8			4.93
AB	5—10						7.3	1.8			5.32
AB	15—20										8.02
B	30—40										12.00
B	60—70										18.18
C	145—155										12.00

Horizon	Organic matter				Particle size analysis %					
	% C	% N	C/N	Ch. a / Cf. a	1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
A	0.96	0.12	8	0.8	2.3	31.2	40.6	7.6	13.3	7.3
AB	0.49	0.07	7		0.9	30.3	38.4	17.4	5.1	8.8
AB	0.25	0.05	5		1.3	26.0	39.5	11.6	14.8	8.1
B	0.21					23.6	40.3	11.2	14.7	10.2
B										
C						27.4	45.5	6.8	11.5	8.8

Horizon	Total analysis % (on ignited base)											
	SiO_2	R_2O_3	Fe_2O_3	Al_2O_3	P_2O_5	CaO	MgO	K_2O	Na_2O	SO_3	MnO	CO_2
A	68.37	18.87	4.35	14.42	0.11	3.26	1.55	2.89	2.25	0.76	0.11	2.17
AB	67.13	19.09	4.31	14.69	0.12	4.32	1.53	2.96	2.22	0.31	0.08	2.34
AB	67.75	18.87	4.61	14.16	0.13	6.91	2.07	2.82	2.17	0.50	0.08	3.53
B	69.43	18.51	4.97	13.46	0.12	4.82	1.57	2.89	2.11	1.04	0.08	5.28
B	72.26	15.76	3.76	11.85	0.13	6.58	3.05	3.55	1.91	0.59	0.11	8.00
C	70.81	17.38	3.41	13.89	0.11	6.07	3.00	2.57	2.22	1.08	0.12	5.28

LUVIC XEROSOL	**Xl**
Brown semidesert soil	Kazakhstan, U.S.S.R.
E.V. Lobova, 1960	Profile 1, p. 124
Location	35 km southeast of Dzheskazgan
Altitude	
Physiography	Watershed plain between Kengir and Sary-Su rivers
Parent material	Loess-like loam on old gravelly alluvium
Vegetation	*Artemisia* desert steppe
Climate	3.71b, isohygrous warm continental desert

Profile description

A	**0-6 cm**	Light brown loam; very thin platy structure.
AB	**6-15 cm**	Light brown loam; thick platy to coarse prismatic structure; slightly compacted.
B	**15-30 cm**	Brown silt loam; prismatic structure; more compacted.
BC	**30-82 cm**	Pale brown loam with white spots; prismatic structure; compact.
IIC1	**82-112 cm**	Gravel with some fine earth and gypsum veins.
IIIC2	**112-160 cm**	Orangish brown clay with pebbles and gypsum crystals.

LUVIC XEROSOL
U.S.S.R.

Horizon	Depth cm	OM %	$CaCO_3$ %	$CaSO_4 \cdot 2H_2O$ %	CEC me/100 g	Water extract analysis %							
						TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na + K
A	0—6	1.81	1.8	0.04	14.0	0.090	0.047	0.000	0.002	0.007	0.016	0.006	0.000
AB	6—14	1.29	6.9	0.04	14.4	0.090	0.050	0.000	0.003	0.006	0.016	0.005	0.000
B	20—30	1.05	9.8	0.04	16.8	0.070	0.056	0.000	0.003	0.003	0.011	0.004	0.000
BC	50—60	0.58	19.4	0.13	15.7	0.130	0.070	0.000	0.002	0.001	0.007	0.004	0.011
IIC1	90—110		9.8	15.84	10.7	1.570	0.039	0.000	0.054	0.965	0.305	0.042	0.080
IIIC2	150—160		21.6	14.69	15.2	1.630	0.037	0.000	0.095	1.055	0.274	0.055	0.102

HAPLIC YERMOSOL	**Yh**
Greyish brown desert soil poor in carbonates	Kazakhstan, U.S.S.R.
E.V. Lobova, 1960	Profile 26, p. 219
Location	Eastern Betpak-Dala plateau
Altitude	
Physiography	Rolling to hilly plain
Parent material	Eluvo-diluvium from granite
Vegetation	*Artemisia* desert
Climate	3.71b, isohygrous warm continental desert

Profile description

A1	**0-5 cm**	Light grey thick porous loamy crust.
A2	**5-14 cm**	Pale brown silt loam; platy structure; friable.
AB	**14-28 cm**	Bright brown silt loam; subangular blocky structure.
B	**28-70 cm**	Cinnamon brown clay loam; prismatic to angular blocky structure; bright white carbonate spots.
C	**70+ cm**	Stony sand.

HAPLIC YERMOSOL
U.S.S.R.

Horizon	Depth cm	% OM	Cation exchange me/100 g						$CaCO_3$ %	$CaSO_4 . 2H_2O$
			CEC	TEB	Ca	Mg	Na	K		
A1	0—5	0.94			5.8	5.1			14.5	0.1
A2	7—15	0.40			3.8	2.6			18.4	0.1
AB	16—24	0.75			8.2	5.2			10.3	0.1
B	30—40	0.94			10.2	1.5			2.2	0.0

Horizon	Water extract analysis %							
	TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na + K
A1	0.086	0.061	0.000	0.003	0.006	0.011	0.006	0.005
A2	0.097	0.059	0.000	0.000	0.003	0.012	0.005	0.002
AB	0.081	0.051	0.000	0.002	0.003	0.012	0.004	0.000
B	0.081	0.047	0.000	0.003	0.007	0.014	0.006	0.000

CALCIC YERMOSOL	**Yk**
Greyish brown desert soil	Turkmenia, U.S.S.R.
E.V. Lobova, 1960	Profile 36, p. 172
Location	Dordul plateau, southwest Ust Urt
Altitude	
Physiography	Level plateau
Parent material	Eluvo-diluvium from Tertiary rocks
Vegetation	Ephemeral desert
Climate	3.71a, Mediterranean warm continental desert

Profile description

A1	**0-2 cm**	Pale sandy porous silt loam crust, non-saline.
A2	**2-10 cm**	Pale yellow loamy sand with white carbonate spots.
AB	**10-25 cm**	Pale yellow loamy sand with white carbonate spots; subangular blocky structure.
B	**25-48 cm**	Pale loamy sand with gravel, carbonates and gypsum.
C	**48-100 cm**	Gravelly loamy sand with rubble.

CALCIC YERMOSOL

U.S.S.R.

Horizon	Depth cm	OM %	$CaCO_3$ %	$CaSO_4 \cdot 2H_2O$ %	CEC me/100 g	Water extract analysis %							
						TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na + K
A	0—2	0.48	18.0	0.13		0.042	0.022	0.000	0.001	0.003	0.006	0.004	0.000
A2	5—10	0.32	16.3	0.13		0.052	0.024	0.000	0.001	0.006	0.004	0.003	0.000
AB	10—15	0.16	18.0	0.14		0.050	0.034	0.000	0.001	0.006	0.003	0.005	0.002
B	30—35		18.7	0.43		0.373	0.017	0.000	0.100	0.093	0.031	0.010	0.060
B	40—45		22.4	2.03		1.360	0.014	0.000	0.155	0.673	0.232	0.027	0.110

Horizon	Particle size analysis %						Total analysis % (on carbonateless base)							
	1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3
A	0.5	58.5	16.4	1.7	6.2	5.5	75.56	12.84	5.00	0.00	3.35	1.85	1.90	0.93
AB	0.2	55.5	9.5	1.5	4.0	9.1	76.07	11.79	5.47	0.00	3.52	1.85	1.65	0.93
B	0.4	57.0	7.2	1.0	4.1	9.6	75.44	12.16	5.68	0.00	3.30	1.38	1.47	0.51
B	0.7	50.6	7.2	1.0	2.6	10.6	70.85	12.91	4.08	2.19	4.00			

CALCIC YERMOSOL	**Yk**
Greyish brown desert soil	Kazakhstan, U.S.S.R.
E.V. Lobova, 1960	Profile 520, p. 188
Location	Near Darya-Sai, Kyzyl Kum desert
Altitude	
Physiography	Rolling to hilly plain
Parent material	Eluvium on hard rock
Vegetation	Ephemeral desert
Climate	3.71b, isohygrous warm continental desert

Profile description

A1	**0-4 cm**	Grey sandy porous loamy crust.
A2	**4-12 cm**	Grey sandy silt loam; platy structure; few unclear white carbonate spots; little gravel.
AB	**12-20 cm**	Brown whitish sandy loam; compacted; few unclear white carbonate spots.
B	**20-35 cm**	Whitish brown sandy loam; less compacted.
IIBC	**35-70 cm**	Gravelly sand; gypsum crystals on pebble surfaces.
IIC1	**70-100 cm**	Gravel with gypsum and carbonates.
IIC2	**100-125 cm**	Coarse gravel with gypsum.
IIC3	**125+ cm**	Coarse gravel with sandstone rubble.

CALCIC YERMOSOL
U.S.S.R.

Horizon	Depth cm	OM %	$CaCO_3$ %	$CaSO_4 \cdot 2H_2O$ %	Water extract analysis % TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na + K
A1	0—4	0.80	10.0	0.1	0.220	0.087	0.000	0.015	0.024	0.014	0.008	0.023
A2	4—10	0.40	11.6	0.1	0.140	0.061	0.000	0.007	0.014	0.012	0.006	0.009
AB	12—20	0.29	13.8	1.7	0.136	0.059	0.000	0.006	0.011	0.012	0.005	0.009
B	25—35	0.26	17.1	2.0	0.612	0.025	0.000	0.006	0.335	0.117	0.012	0.018
IIBC	40—50		8.6	69.0	1.400	0.025	0.000	0.048	0.798	0.313	0.024	0.016
IIC1	70—80		5.2	65.3	1.508	0.018	0.000	0.055	0.876	0.295	0.050	0.028
CII3	140—150		10.7	6.7	1.500	0.021	0.000	0.072	0.818	0.248	0.048	0.070

Horizon	Particle size analysis %						Total analysis % (on carbonateless base)								
	1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	P_2O_5	CaO	MgO	Na_2O	K_2O
A1	10.4	57.5	15.2	2.6	8.3	6.0	75.21	10.64	5.06	0.58	0.10	2.50	2.26	1.57	1.97
A2	9.9	48.9	16.8	5.1	9.9	9.4	73.10	10.27	6.21	0.58	0.15	2.64	2.44	1.33	2.70
B	8.5	56.2	6.7	1.5	11.9	15.2	73.51	10.85	7.61	0.59	0.10	0.09	2.40	1.28	2.66
IIBC	31.9	25.6	6.4	2.1	16.9	17.1									
IIC3	47.6	13.3	4.1	2.9	7.9	24.2									

TAKYRIC YERMOSOL	**Yt**
Greyish brown primitive soil	Turkmenia, U.S.S.R.
E.V. Lobova, 1960	Profile 20, p. 197
Location	0.5 km south of Messerian
Altitude	
Physiography	Flat old river terrace
Parent material	Old alluvium
Vegetation	Lichens and sparse halophytes
Climate	3.71a, Mediterranean warm continental desert

Profile description

A1	**0-5 cm**	Pale light soft crust.
A2	**5-9 cm**	Pale porous compacted loam.
AB	**9-20 cm**	Pale grey heavy loam.
B	**20-35 cm**	Grey loam with salt efflorescences; inclusions of charcoal, brick debris.
BC	**35-150 cm**	Grey loam with dark mottles.
C	**150+ cm**	Grey loam with gleyic mottling.

TAKYRIC YERMOSOL

U.S.S.R.

Horizon	Depth cm	% OM	% C	% N	C/N	$CaCO_3$ %	$CaSO_4 . 2H_2O$ %
A1	0—5	0.73	0.42	0.06	7.0	15.9	0.2
A2	5—9	0.65	0.38	0.04	9.5	15.9	0.2
AB	15—20	0.81	0.47	0.06	7.9	18.2	0.3
B	22—27	0.62	0.36	0.05	7.2	17.7	2.1
BC	45—50	0.68	0.40	0.06	6.7	21.3	0.4
C	160—170					19.3	0.2

Horizon	Water extract analysis %							
	TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na + K
A1	0.330	0.037	0.000	0.086	0.085	0.016	0.003	0.086
A2	0.290	0.042	0.000	0.078	0.042	0.008	0.003	0.071
AB	0.720	0.033	0.000	0.275	0.144	0.014	0.008	0.228
B	1.910	0.018	0.000	0.186	0.977	0.306	0.043	0.161
BC	0.610	0.025	0.000	0.151	0.176	0.033	0.018	0.127
C	0.410	0.025	0.000	0.131	0.093	0.023	0.015	0.083

GLEYIC SOLONCHAK Zg

Meadow Solonchak	Turkmenia, U.S.S.R.
E.V. Lobova, 1960	Profile 41, p. 12
Location	Uzboi valley
Altitude	
Physiography	Flat second terrace
Parent material	Old alluvial sand
Vegetation	Saxaul shrub
Climate	3.71a, Mediterranean warm continental desert

Profile description

A	**0-7 cm**	Dark grey loamy sand.
AB	**7-16 cm**	Grey loamy sand with salt efflorescences.
B	**16-25 cm**	Light grey loamy sand with rust-coloured mottles and humus infiltrations; numerous salt efflorescences.
BC	**25-40 cm**	Greyish yellow medium sand.
C	**40-160 cm**	Grey micaceous medium sand.

GLEYIC SOLONCHAK

U.S.S.R.

Horizon	Depth cm	OM %	$CaCO_3$ %	$CaSO_4 \cdot 2H_2O$ %	Water extract analysis %							
					TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na + K
A	0—5	0.76	13.4	1.0	0.790	0.044	0.000	0.141	0.354	0.038	0.003	0.239
AB	5—10	0.52	16.3	0.7	1.290	0.042	0.000	0.430	0.310	0.028	0.001	0.404
AB	10—15	0.34	15.2	0.7	1.500	0.039	0.000	0.586	0.285	0.019	0.002	0.508
B	15—20	0.37	13.7	1.3	2.020	0.024	0.000	0.615	0.572	0.173	0.004	0.478
BC	30—35	0.12	9.2	0.4	0.580	0.024	0.000	0.169	0.167	0.054	0.004	0.129
C	75—80		8.5	1.4	0.170	0.031	0.000	0.052	0.026	0.007	0.001	0.048
C	150—160		9.8	1.3	0.080	0.029	0.000	0.018	0.008	0.009	0.001	0.014

MOLLIC SOLONCHAK	**Zm**
Meadow Solonchak	Kirgizia, U.S.S.R.
A.M. Mamytov, 1963	Profile 374, p. 397
Location	At-Bashi valley, central Tien Shan
Altitude	
Physiography	Intermontane depression, river terrace
Parent material	River alluvium
Vegetation	Dry steppe with halophytes
Climate	3.71b, isohygrous warm continental desert
Ground water	150 cm

Profile description

A1	**0-6 cm**	Brown heavy loam; fine granular structure; white salt efflorescences.
A2	**6-14 cm**	Brownish grey loess-like loam; crumb structure; many roots; white salt efflorescences.
AB	**14-30 cm**	Brownish grey loess-like loam; coarse subangular blocky structure; many roots.
B1	**30-49 cm**	Greyish brown loess-like loam; coarse subangular blocky structure; many roots; salt efflorescences.
B2	**49-72 cm**	Greyish brown heavy loam; weak subangular blocky structure; many roots.
BC	**72-100 cm**	Grey loess-like loam; weak subangular blocky structure; hard.
C	**100-150 cm**	Light grey clay with grey shade; angular blocky structure.

MOLLIC SOLONCHAK
U.S.S.R.

Horizon	Depth cm	pH H_2O	pH KCl	% OM	$CaCO_3$ %	CEC me/100 g	Particle size analysis % 1–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
A1	0—6	8.00		4.08	13.0		0.65	9.80	22.55	14.26	21.39	9.59
A2	6—14	8.46		3.39	17.0		0.84	1.71	20.47	12.03	24.61	16.54
AB	15—25	8.68		2.73	22.3		1.43	4.08	20.35	11.54	20.38	20.68
B1	35—45	8.73		2.13	22.3		0.30	1.38	22.70	11.60	24.84	15.40
B2	55—65	8.64		1.73	23.0		0.35	0.12	21.30	12.37	21.93	15.03
BC	80—90	8.70		1.37	27.0		0.50	1.51	14.22	12.25	27.57	14.58
C	120—130	8.56		1.33	21.5		0.30	14.12	19.56	11.06	16.18	13.36

Horizon	Water extract analysis % TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na+K
A1	2.990	0.057	0.000	0.426	0.903	0.272	0.108	0.261
A2	2.320	0.037	0.000	0.278	0.823	0.240	0.088	0.146
AB	1.613	0.035	0.000	0.311	0.484	0.064	0.067	0.246
B1	1.469	0.038	0.000	0.339	0.403	0.027	0 065	0.273
B2	1.252	0.038	0.000	0.308	0.336	0 018	0.042	0.274
BC	0.781	0.059	0.000	0.190	0.189	0.009	0.017	0.193
C	0.136	0.047	0.000	0.024	0.033	0.015	0.006	0.021

ORTHIC SOLONCHAK **Zo**

Solonchak	Turkmenia, U.S.S.R.
A.Z. Genusov and T.K. Karimov, 1958	Profile 22-a, p. 100
Location	8 km south of Kunya-Urgench
Altitude	50 m
Physiography	Flat plain of old river terrace
Parent material	Old clayey alluvium
Vegetation	Bare surface
Climate	3.71a, Mediterranean warm continental desert
Ground water	Depth 10.75 m, salinity 33 g/l

Profile description

A	**0-12 cm**	Brownish grey clay with dense white salt sparklings; hard, friable, porous; clear boundary.
B	**12-46 cm**	Light greyish brown heavy clay with numerous grey and rust-coloured mottles, and white salt sparklings and veins; hard, compact; structureless; clear boundary.
IIC1	**46-80 cm**	Pale brown medium silt loam with a few grey and rust-coloured mottles and numerous white salt spots and veins; hard and compact; diffuse boundary.
IIC2	**80-116 cm**	Pale brown light silt loam with a few grey, rust-coloured and white spots; slightly hard; diffuse boundary.
IIC3	**116-130 cm**	Pale light silt loam with grey, rust-coloured and white spots; slightly hard; structureless; clear boundary.
IIIC	**130+ cm**	Pale brown to brown heavy clay with intercalations of silt loam.

ORTHIC SOLONCHAK

U.S.S.R.

Horizon	Depth cm	Particle size analysis %						
		1–0.25	0.25–0.1	0.1–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
A	0—12	1.69	6.53	13.03	10.90	14.50	31.05	22.40
B	12—46	0.07	0.40	6.03	6.65	31.10	33.75	22.00
IIC1	46—80	0.50	6.58	19.07	43.15	11.40	10.60	8.80
IIC2	80—116	0.67	5.87	15.66	49.55	11.40	9.50	7.35
IIC3	116—130	0.32	1.70	12.23	63.90	9.90	7.05	4.90
IIIC	130—171	0.25	0.10	2.55	14.15	26.00	35.00	21.95

Horizon	Depth cm	Water extract analysis %							
		TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na + K
A	0—12	9.590	0.012	0.000	4.490	0.078	0.848	0.322	1.850
B	12—46	5.560	0.011	0.000	2.672	0.461	0.182	0.372	1.046
IIC1	46—80	2.104	0.013	0.000	0.908	0.281	0.062	0.094	0.477
IIC2	80—116	1.410	0.012	0.000	0.591	0.255	0.052	0.056	0.323
IIC3	116—130	0.764	0.012	0.000	0.314	0.138	0.028	0.032	0.179
IIIC	130—171	3.348	0.012	0.000	1.247	0.676	0.156	0.158	0.705
	171—194	1.384	0.011	0.000	0.531	0.248	0.040	0.086	0.259
	194—225	1.312	0.012	0.000	0.538	0.239	0.042	0.065	0.309
	225—265	1.288	0.022	0.000	0.470	0.332	0.066	0.069	0.267
	265—305	0.868	0.010	0.000	0.338	0.179	0.036	0.048	0.179
	305—339	1.420	0.011	0.000	0.510	0.295	0.048	0.067	0.294
	339—375	1.920	0.015	0.000	0.731	0.411	0.042	0.099	0.441
	375—408	1.664	0.012	0.000	0.570	0.364	0.048	0.076	0.349

TAKYRIC SOLONCHAK	**Zt**
Takyr	Turkmenia, U.S.S.R.
A.Z. Genusov and T.K. Karimov, 1958	Profile 3716, p. 32
Location	Kunya-Darya plain
Altitude	50 m
Physiography	Flat surface
Parent material	Old stratified alluvium
Vegetation	Algae
Climate	3.71a, Mediterranean warm continental desert

Profile description

A1	**0-4 cm**	Brown, hard, porous, cloudy, heavy loamy crust, very durable.
A2	**4-22 cm**	Light grey heavy loam with brownish mottles; very thin platy structure; a few white salt spots.
B	**22-36 cm**	Pale grey sandy loam; platy structure; slightly hard.
BC	**36-62 cm**	Pale greyish silty medium loam; compact, hard; a few white salt spots.
IIA1	**62-81 cm**	Brownish grey heavy loam; very coarse columnar structure; very hard and compact; ancient buried agro-irrigational horizon.
IIA2	**81-118 cm**	Light grey sandy silt loam.
IIA3	**118-128 cm**	Light grey light loam.
IIIC1	**128-180 cm**	Brownish pale clay with a few rust-coloured mottles of iron oxides; thin platy structure; very hard and compact; a few white salt spots.
IIIC2	**180-300 cm**	Brown clay with bright rust-coloured and grey mottles; thin platy structure; very hard and compact; a few white salt spots.

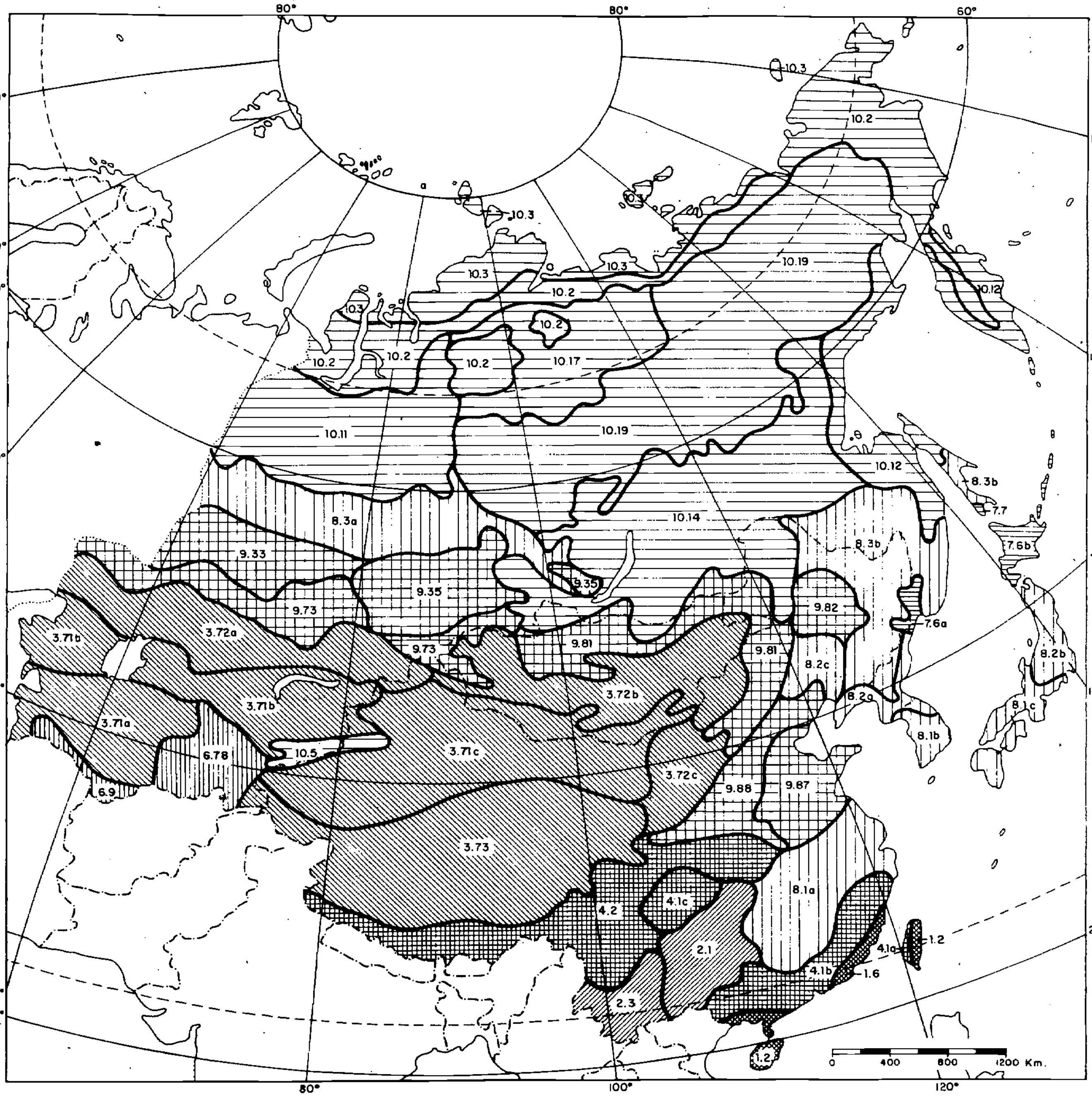
TAKYRIC SOLONCHAK
U.S.S.R.

Horizon	Depth cm	pH		Cation exchange me/100 g						Organic matter			
		H_2O	KCl	CEC	SSP	Ca	Mg	K	Na	% C	% N	C/N	% OM
A1	0—4			9.0	4.3				0.39	0.18	0.04	4.6	0.27
A2	4—22			11.2	1.9				0.21	0.28	0.05	5.5	0.51
B	22—36									0.22	0.03	7.2	0.36
BC	36—62									0.31	0.05	6.2	0.80
IIA1	62—81			8.5	2.4				0.21	0.18	0.03	6.0	0.31

Horizon	Particle size analysis %						
	1–0.25	0.25–0.1	0.1–0.05	0.05–0.01	0.01–0.005	0.005–0.001	< 0.001 mm
A1	2.03	21.89	12.87	10.35	3.47	14.42	34.97
A2	0.41	3.06	11.34	19.70	13.15	27.67	24.67
B	0.34	3.38	19.39	54.15	5.77	8.02	8.95
BC	0.22	0.73	4.93	45.30	15.95	17.60	15.27
IIA1	0.27	0.54	4.03	42.97	17.57	18.15	16.47
IIA2	0.48	6.43	34.32	50.80	2.10	3.32	2.55
IIA3	0.08	0.23	2.80	74.15	12.42	4.22	6.10
IIIC1	0.05	0.09	0.19	34.25	25.72	23.30	16.40
IIIC2	0.06	0.04	0.64	22.37	21.27	32.55	23.07

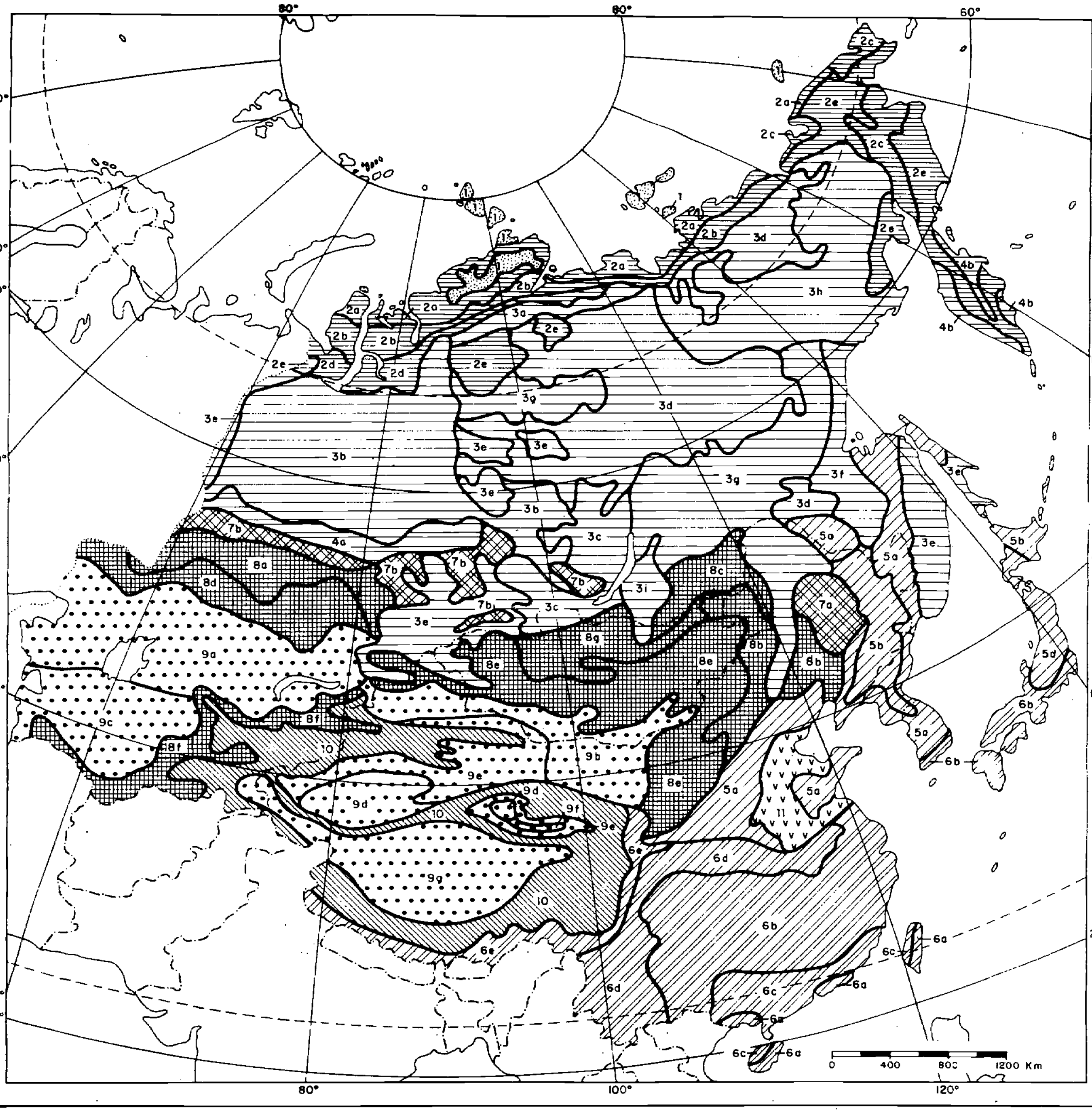
Horizon	Water extract analysis %							
	TS	HCO_3	CO_3	Cl	SO_4	Ca	Mg	Na + K
A1	0.228	0.030	0.000	0.052	0.036	0.018	0.009	0.025
A2	0.600	0.017	0.000	0.161	0.148	0.092	0.013	0.051
B	0.428	0.015	0.000	0.091	0.135	0.060	0.004	0.053
BC	0.396	0.016	0.000	0.126	0.118	0.046	0.019	0.055
IIA1	0.412	0.019	0.000	0.101	0.092	0.034	0.006	0.066
IIA2	0.172	0.023	0.000	0.035	0.033	0.018	0.014	0.019
IIA3	0.168	0.019	0.000	0.031	0.044	0.018	0.013	0.030
IIIC1	0.220	0.022	0.000	0.059	0.061	0.028	0.017	0.011
IIIC2	0.532	0.018	0.000	0.070	0.239	0.084	0.011	0.049

1. CLIMATES



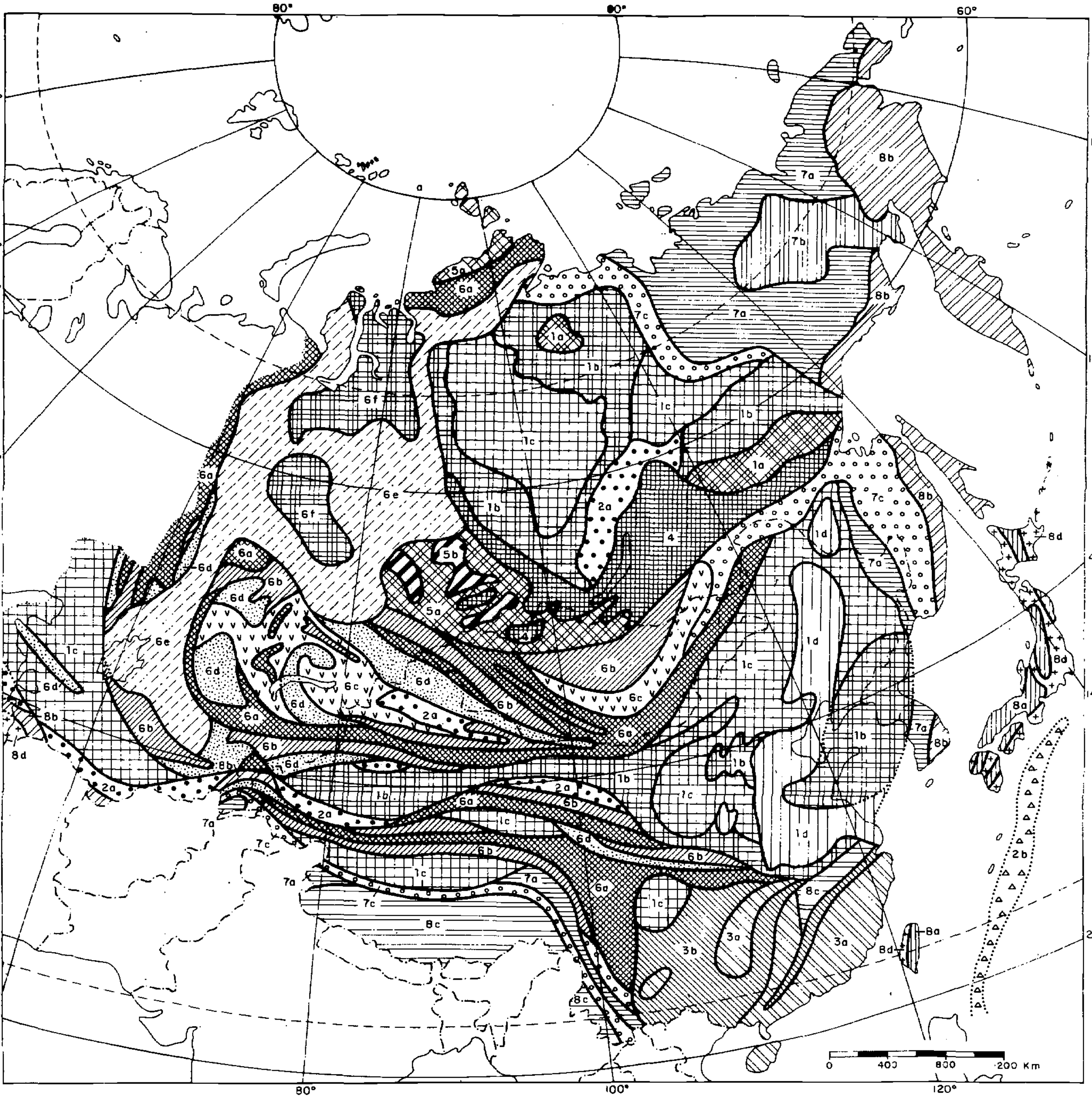
1. Tropical
2. Tierra fría
3. Desert
4. Subtropical
6. Mediterranean
7. Marine
8. Humid continental
9. Steppe
10. Polar-alpine

2. VEGETATION



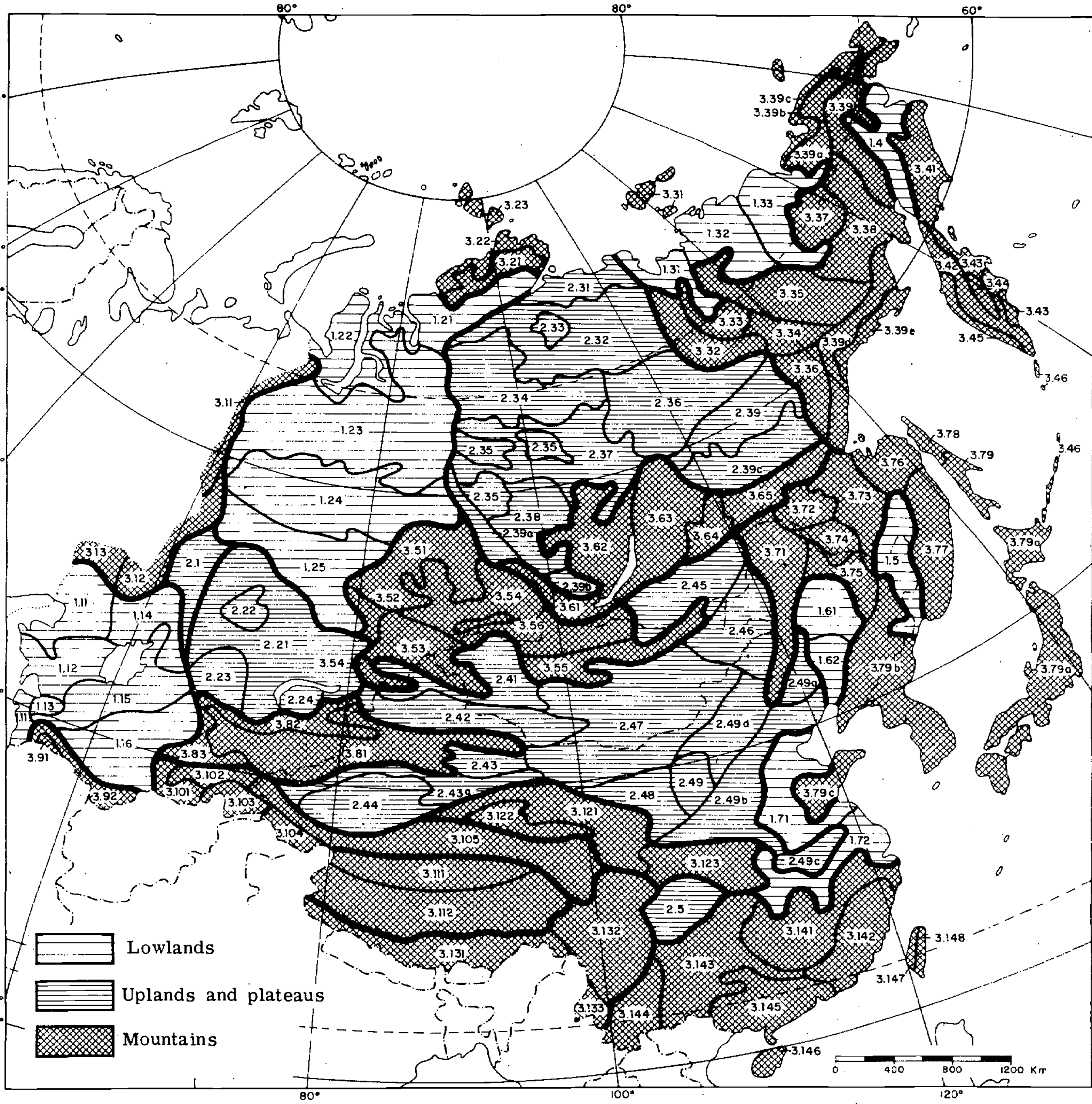
- 1. Arctic wastes
- 2. Tundra
- 3. Taiga forest
- 4. Temperate deciduous small-leaf forest
- 5. Temperate deciduous broadleaf forest
- 6. Subtropical and tropical forests
- 7. Meadow steppe
- 8. Steppe
- 9. Desert
- 10. Subalpine and alpine meadows
- 11. Arable land with unknown natural vegetation

3. GEOTECTONICS



1a. Basement outcrops
1b. Regions with thin sedimentary cover, or partly without cover
1c. Regions with thick sedimentary cover
1d. Regions of recent subsidence
2a. Continental marginal depressions
2b. Oceanic marginal depressions
3a. Anticlinoria developed from anticlines
3b. Synclinoria developed from synclines
4. Baikal folding and Precambrian formations in Caledonian folded massifs
5a. Caledonian folding and zones of early consolidation in region of Hercynian folding
5b. Depressions with middle and upper Paleozoic sediments overlying Caledonian basement
6a. Geoanticlinal zones with surface or shallow beds of Hercynian folded complex of Precambrian rocks
6b. Gotland Ordovician geosynclinal zones
6c. Gotland Devonian geosynclinal zones
6d. Carbono-Permian geosynclinal zones
6e. Regions with relatively shallow Paleozoic basement strata in Epihercynian platforms
6f. Regions with deep Paleozoic basement strata in Epihercynian platforms
7a. Geoanticlinal zones with surface or shallow Precambrian beds
7b. Central folded massifs
7c. Geosynclinal zones
8a. Geoanticlinal zones with surface or shallow Precambrian beds
8b. Geosynclinal zones of the Pacific belt and southern Asian mountain regions
8c. Central massifs in geoanticlinal zones of Cenozoic folding
8d. Subsided central massifs and recent depressions in geosynclinal zones of Cenozoic folding

4. GEOMORPHOLOGY

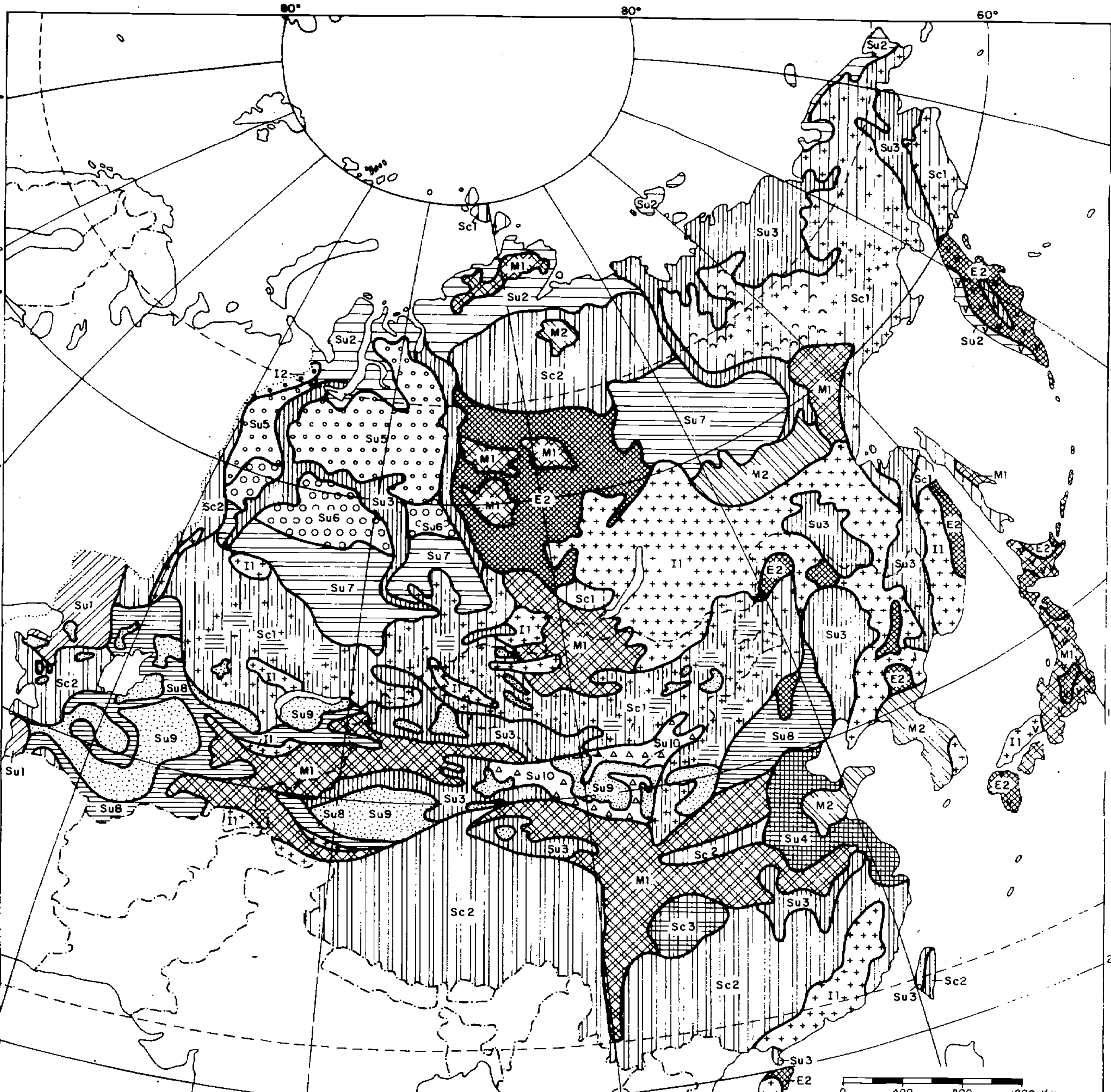


1.1 Turan plain
1.2 Western Siberian lowland
1.3 Northern Siberian lowland
1.4 Penzhina-Anadyr lowland
1.5 Ussuri-Khanka lowland
1.6 Manchurian plain
1.7 North China and Yangtze plains

2.1 Turgai plateau
2.2 Kazakh upland
2.3 Central Siberian montane plateau
2.4 Central Asian plateau
2.5 Szechwan basin plateau

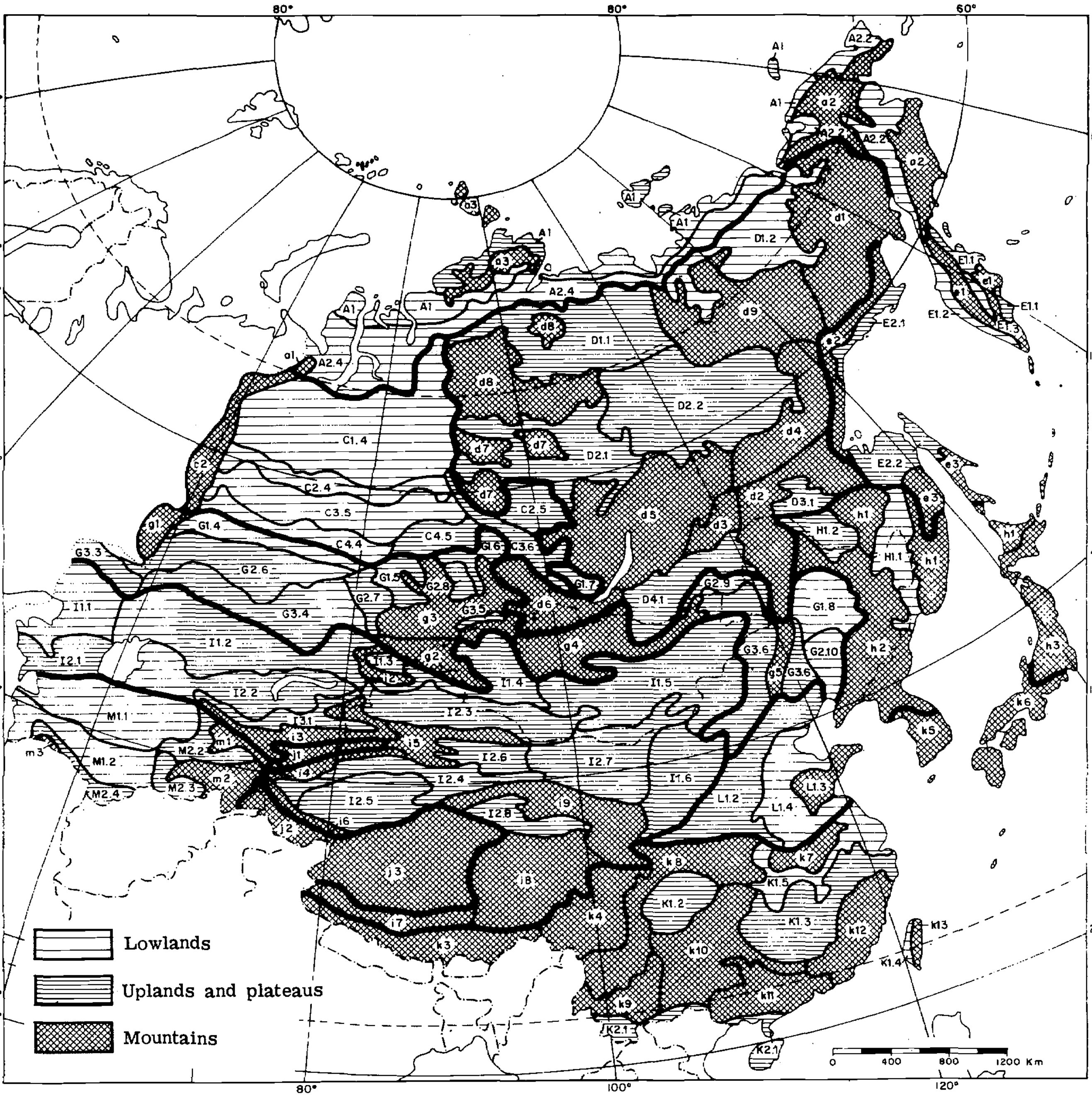
3.1 Urals
3.2 Taimyr region
3.3 Eastern Siberian mountain system
3.4 Koryak-Kamchatka-Kurilian volcanic chain
3.5 Altai-Sayan region
3.6 Baikal mountain country
3.7 Eastern Asian mountain system
3.8 Tien Shan region
3.9 Kopet Dag region
3.10 Pamir-Kunlun region
3.11 Tibetan region
3.12 Nan Shan region
3.13 Himalayan region
3.14 Southern China mountain system

5. LITHOLOGY



- Su1 Tertiary and Pleistocene saliferous marine sediments, mainly unconsolidated
- Su2 Recent fluvial and coastal sediments
- Su3 Subrecent and recent fluvial and lacustrine sediments
- Su4 Recent deltaic alluvial sediments
- Su5 Glacial moraine deposits
- Su6 Fluvioglacial sediments (sand, loam, clay)
- Su7 Postglacial fluvial loess-like loams
- Su8 Loess
- Su9 Shifting sands (originally fluvial, then aeolian)
- Su10 Disintegrated rock deposits (hamadas)
- Sc1 Consolidated clastic sediments (sandstone, siltstone, shale, conglomerate)
- Sc2 Consolidated carbonate sediments (limestone, dolomite, marl)
- Sc3 Cretaceous to Tertiary purple clay shale and sandstone
- M1 Metamorphic rocks (gneiss, schist, phyllite, quartzite, slate)
- M2 Granitized and migmatized basement complex (granite, gneiss, migmatite)
- I1 Acid intrusive rocks (granite, diorite, quartz porphyry, syenite, gneiss)
- I2 Basic intrusive rocks (dolerite, gabbro, peridotite, serpentinite, pyroxenite, norite)
- E1 Acid effusive rocks (rhyolite, quartzite, porphyry, dacite, trachyte)
- E2 Basic effusive rocks (basalt, diabase, dolerite, andesite)
- E3 Recent volcanic tuff and ash

6. SOILS



SOIL-BIOCLIMATIC PROVINCES

A. Eurasian polar

C. Central taiga

D. Eastern Siberian cryogenic taiga

E. Far Eastern taiga meadow-forest

G. Central forest-steppe and steppe

H. Eastern forest

I. Desert steppe and desert

J. High-mountain desert

K. Subtropical humid forest

L. Subtropical xerophytic forest

M. Subtropical desert steppe and desert

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