Soil Brief *China 6*

PEOPLE'S REPUBLIC OF CHINA

Reference soils of the subtropical mountains of Guangdong Province

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ISRIC

Institute of Soil Science - Academia Sinica

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ISSAS

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Reference soils of the subtropical mountains of Guangdong Province

ISRIC Soil Monoliths:

Number	*FAO-Unesco*	*Soil Taxonomy*	*Chinese Classification*
CN 29	Ferralic Cambisol	Typic Dystrochrept	Haplic Para-Red Soil
CN 31	Chromic Luvisol	Typic Hapludalf	Luvic Brown Limestone Soil
CN 32	Ferralic Cambisol	Typic Hapludox	Haplic Latored Soil

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ABSTRACT

Three representative soils, located in the Quingyun Mountains which form part of the extended Subtropical Nanling Mountains of Guangdong Province were studied for the establishment of a Chinese soil reference collection and pedon database. Description and sampling were carried out in the framework of an European Community supported cooperation programme between the "Institute of Soil Science, Academia Sinica", Nanjing, People's Republic of China and the "International Soil Reference and Information Centre", Wageningen, The Netherlands.

The climate of the Nanling Mountains is of a monsoon type and classified as Cw (Köppen system). Parent materials are shale, granite and marble. Slopes are locally covered by a layer of colluvial material. The natural vegetation changes with altitude. Agricultural activities are concentrated in the intermontane basins and depend on a supply of irrigation water.

The first soil studied is a moderately deep, well drained, strong brown silty clay overlying a buried profile derived from shale. Soil depth varies over short distances and the soil is classified as a Haplic Para-Red Soil (Chinese classification) or a Ferralic Cambisol (FAO-Unesco).

The second soil studied is a deep, well drained, dark reddish brown, gravelly to stony clay derived from grey marble. In the subsoil, clay accumulation is observed. Profile depth and stoniness vary at short distances. The soil is classified as a Luvic Brown Limestone Soil (Chinese classification) or a Chromic Luvisol (FAO-Unesco).

The third soil studied is a deep, well drained, dark brown to yellowish red, gravelly clay soil derived from granite covered by a dark yellowish brown colluvial layer. The soil is classified as a Haplic Latored Soil (Chinese classification) or a Ferralic Cambisol (FAO-Unesco).

The utilization of the three soils is seriously limited by the steep slopes, which cause a high erosion hazard. Forestry and the processing of its products are recommended.

摘　要

爲建立中國土壤樣品參比庫和土壤剖面數據庫，三個典型土壤剖面采自廣東青雲山，它屬于廣東南嶺山脉向南的延伸。該項目在歐洲共同體ＳＴＤ２資助下，由中國科學院南京土壤所同荷蘭國際土壤信息參比中心合作實施。

南嶺山系屬于典型的季風氣候區（Ｃｗ）。母岩有頁岩、花崗岩和大理石，坡地上有時見坡積物覆蓋。植被類型與地形高度相關，而農業活動集中在山間盆地，并且有賴于灌溉。

第一個土壤剖面，土層較深，排水良好。暗棕色粉粘質土壤覆蓋在頁岩發育的土壤剖面上。土層深度在短程距離内出現變异。該土壤分類爲普通淋紅壤（中國土壤系統分類，１９９０）即鐵鋁雛形土（ＦＡＯ土壤分類，１９８９）。

第二個土壤剖面，土層深厚，排水良好，暗紅棕色石質粘壤，由大理石發育而成。在心土層中可見粘粒積累。在短程距離内土層深度和石質接觸出現變异。該土壤分類爲淋溶棕色石灰土（中國土壤系統分類，１９９０）即黯色淋溶土（ＦＡＯ土壤分類，１９８９）。

第三個土壤剖面，土層深厚，排水良好，暗棕到紅黄色粘質土壤，發育于花崗岩，而被一層暗黄棕色坡積物覆蓋。該土壤分類爲普通赤紅壤（中國土壤系統分類，１９９０）即鐵鋁雛形土（ＦＡＯ土壤分類，１９８９）。

上述的土壤由于坡度影響，利用受限，并受土壤侵蝕危害。應當鼓勵發展林業以及它的加工業，同時必須防止環境退化。

FOREWORD

The objective of a Soil Brief is to provide a description of a reference soil typical for a certain agro-ecological zone. The Soil Brief is composed of a text part which includes some graphical presentations of the most outstanding phenomena as well as data annexes. The reference soils are situated in the subtropical mountains of Guangdong Province, People's Republic of China.

A Soil Brief is written for soil specialists and non-soil specialists. For the latter the comprehensive field and laboratory data as being processed with the ISRIC Soil Information System (ISIS) are often too complex and/or too detailed and therefore require clarification in the text. For the soil scientist the text part can be of use as it summarizes the important land and soil qualities, relevant aspects of soil management and soil formation. Furthermore, it provides access to additional information from research and discussions, which cannot be stored in the computerized database. Also within the text reference is made to specific literature that can be consulted in order to enter more in detail.

In this Soil Brief, the text part includes a general characterization of SE China presenting climate, geology and geomorphology (Chapter 1). Also a more specific description is given of the subregion in which the studied soils are situated (Chapter 2). Next a description and discussion of the major characteristics of each of the soils and their taxonomical classification follows, as well as their location and occurrence (Chapter 3). An evaluation of the land qualities and limitations for assessing appropriate land use is included. In the annexes the soil and environmental data, available from field, laboratory and office work are given.

In 1992 the "Institute of Soil Science, Academia Sinica" (ISSAS), Nanjing, People's Republic of China and the "International Soil Reference and Information Centre" (ISRIC), Wageningen, The Netherlands described and sampled in southeast-China reference soils for the establishment of a Chinese soil reference collection and pedon database at ISSAS. Duplicates of these soils were collected for ISRIC's world soil collection. In this Soil Brief three of these reference soils are presented.

Valuable comments on draft versions of this report were received from ISSAS and ISRIC staff, and by Dr. T. de Meester. Soil analytical work was carried out at the soil laboratories of ISSAS and ISRIC. The editing and final lay-out of the document was done at ISRIC with contributions of Dr. E.M. Bridges (editing), Ms M.B. Clabaut (text processing) and Ms J.W. Resink (map compilation). Useful comments on the draft of this Soil Brief were obtained from Mr. A.E. Hartemink.

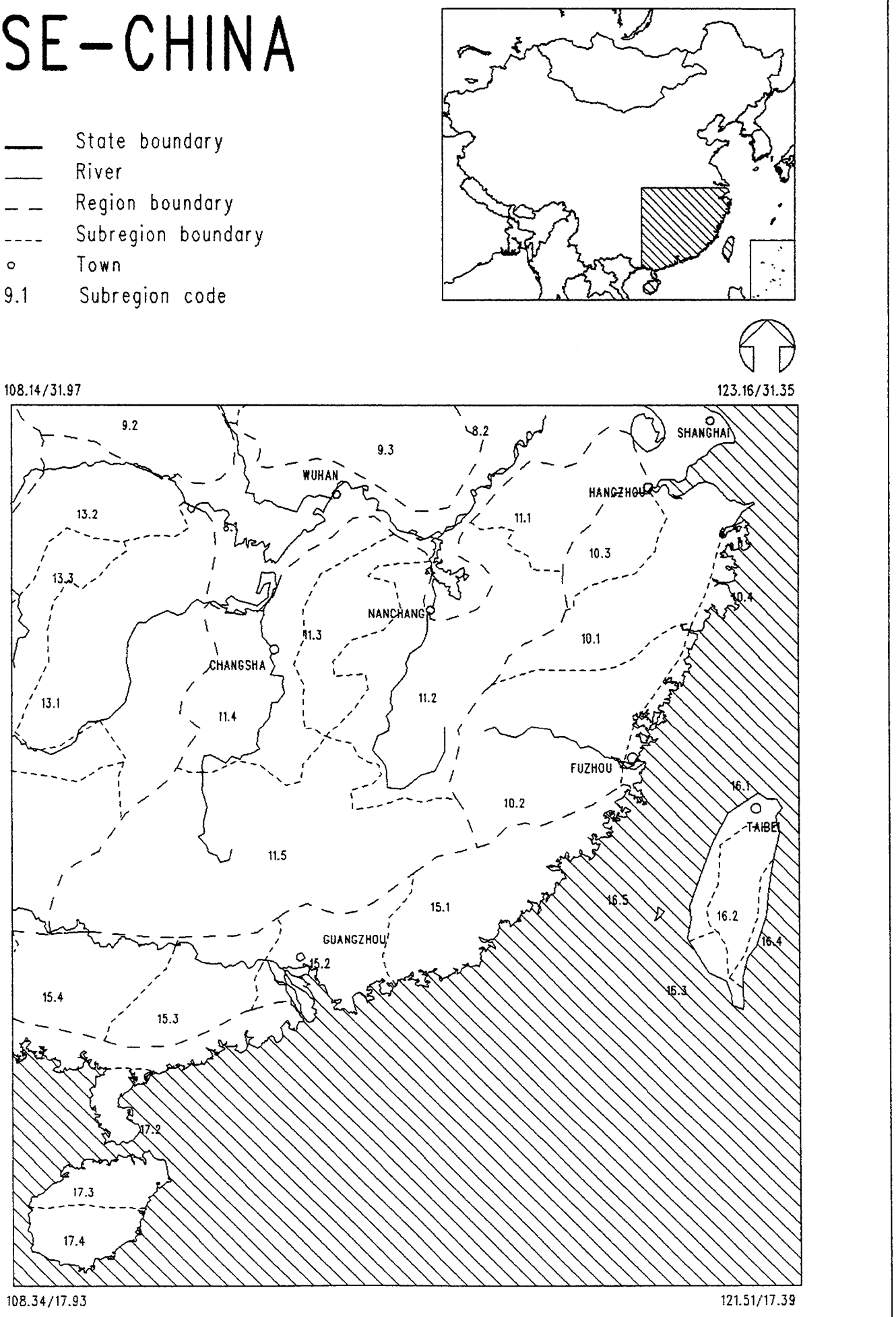


Figure 1 Major physiographic (sub)regions of South-eastern China.

1 THE MAJOR ECOLOGICAL ZONES OF SOUTHEAST CHINA

1.1 Introduction

The southeastern part of China has a montane topography, partly interwoven with broad basins and valleys. The (sub)tropical monsoon climate has put a strong imprint on the landforms and, consequently, on soil development. Southeast China is part of the Subtropical Humid Division (Zhao Songqiao, 1986). Within this division the following natural regions can be distinguished from north to south (see Fig. 1):

- Middle and lower Changjiang Plain
- Qinling-Daba Mountains
- Southeast Coast
- South Changjiang Hills and Basins
- Yunnan-Guizhou Plateau
- Lingnan Hills

Only the Middle and Lower Changjiang Plain and the South Changjiang Hills and Basins are discussed in this chapter. They are indicated in Fig. 1 with the codes 8 and 11, respectively.

1.2 Middle and lower Changjiang plain

Leaving the mountains of Central China through a chain of deep gorges, the large river Changjiang (Yangtze Kiang) flows through vast, flat, densely populated plains, spotted with small and large lakes, and drains in the East China Sea. It has been developed along a great fault line and its extensive valley plains have been mostly located at dominantly submergent basins since the Cretaceous Period.

The middle and lower Changjiang alluvial plain lies at an elevation below 200 m a.s.l. at the end of the gorges in the west and declines gradually over a total distance of 1800 km to the sea. At the confines of Wuhan in the middle section its altitude is already below 25 m a.s.l. In the lower-middle section, the largest freshwater lake of China (Poyang Lake) is found.

The region is characterized by high temperatures and heavy precipitation during the growing season (summer), which results in a high potential for agriculture. It is possible to practice the highly productive rice-rice-wheat triple cropping system. Precipitation ranges from 900 to 1500 mm with 50 to 60% concentrated in summer and autumn. Temperatures, although (very) high in summer, can drop near or below zero in January.

The region is most important for food crops and economic forests. The great contrast between the intensively used and densely populated plains and the rather extensively used and sparsely populated slope lands is outstanding. The zonal vegetation at the slope land is mixed evergreen and deciduous broad-leaved forest, although most of it has been destroyed and substituted by secondary vegetation or tree crops. Erosion control and the improvement of soil fertility are important measures (Zhao Qiguo, 1988).

1.3 South Changjiang hills and basins

To the south of the Changjiang plains lies an extensive area of hills and basins, surrounded by mountains of 1000 m a.s.l. but occasionally over 2000 m a.s.l.: Huanggang Mountain (2157 m a.s.l.) in the Wuyi Mountains is the highest peak in southeast China. These mountains form the watershed between the drainage basin of the Changjiang and the basin of the Zhujiang (Pearl) river of Guangdong Province.

The SW-NE tending low mountains have been formed by the Mesozoic Yanshan Tectonic Movement resulting in ridges and valleys. They have been dissected by numerous rivers (Zhao Qiguo, 1988). Loose, easily erodible Tertiary and Quaternary red beds deposited in basins and valleys have been largely dissected into hills with an elevation below 500 m a.s.l.

The climate is characterized by a rainy spring and a hot summer (± 30°C). Annual precipitation is between 1400 to 1700 mm, 40 to 50% of which is concentrated from April to June. From July to September frequent droughts may occur. A second peak of precipitation follows in October or November. Temperatures are higher than in the northern area and January temperatures hardly ever drop below 0°, except at higher elevations. The mean temperature in July reaches 30°C, with an absolute maximum of 38°C.

Soils occurring in this region are the so called Typic Red Soils and Yellow-Brown Soils with some Paddy soils in the lower cultivated and irrigated zones.

The zonal vegetation type is the profuse and luxuriant evergreen broad-leaved forest. The region is a well-known base of tea and wood. Development of economic forests should be emphasized in this region and attention should be paid to the prohibition of tree felling and the reforestation of the mountain lands (Zhao Qiguo, 1988).

2 NANLING MOUNTAINS

2.1 Introduction

The South Changjiang hills and basins area can be subdivided in a number of subregions. One of them is the Nanling Mountains indicated in Fig. 1 with the code 11.5.

2.2 Climate

Winter lasts for one to two months, usually with frost periods and occasionally with snow. The mean temperature in January ranges from 8 to 10°C. Annual precipitation totals about 1500 mm, with two peaks in the southern parts (May to June and August), and three peaks in the northern part (April, June and August).
The climate of SE China is of a monsoon type; high precipitation and high temperatures in summer, low temperatures and dryness in winter. It is classified as Cw (Köppen system).

Wengyuan meteorological station, 10 km NNW of monolith site CN 29 and 30 km WSW of site CN 31 and Jiekou meteorological station, 12 km SW of site CN 32 have been taken as representative for the reference profiles. The data of both stations were used for climatic diagrams made with SOLGRAPH (Brunt & Kauffman, 1995). Fig. 2 and 3 show monthly data of the maximum, average and minimum temperatures and in Fig. 4 and 5 the monthly precipitation and evaporation are shown.

2.3 Landscape and soils

The Nanling Mountains form the great topographic divide between Central China and South China. It extends from west to east for more than 600 km and from north to south for about 200 km. Its is also the water divide between the Changjiang River (Jangtze Kiang River) and the Zhujiang River (Pearl River).

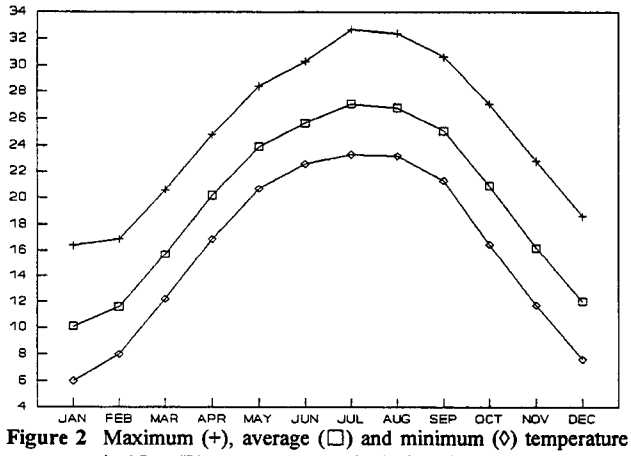


Figure 2 Maximum (+), average (□) and minimum (◊) temperature in °C at Wengyuan meteorological station.

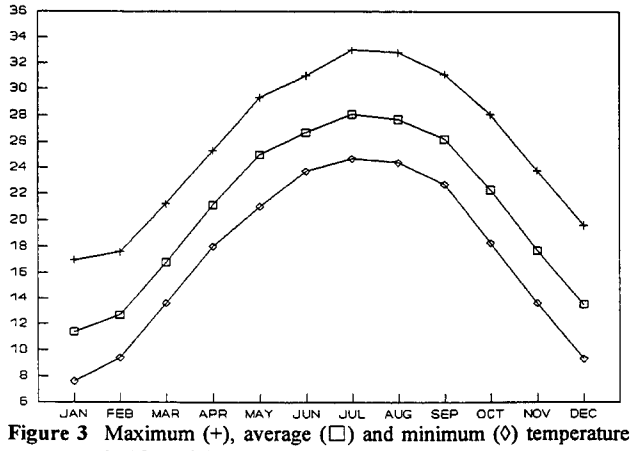


Figure 3 Maximum (+), average (□) and minimum (◊) temperature in °C at Jiekou meteorological station.

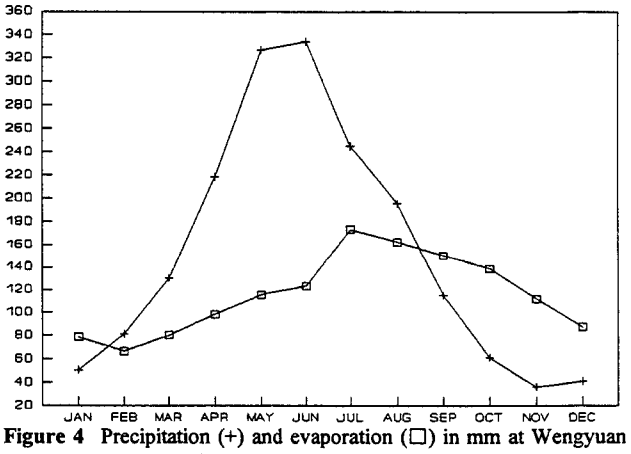


Figure 4 Precipitation (+) and evaporation (□) in mm at Wengyuan meteorological station.

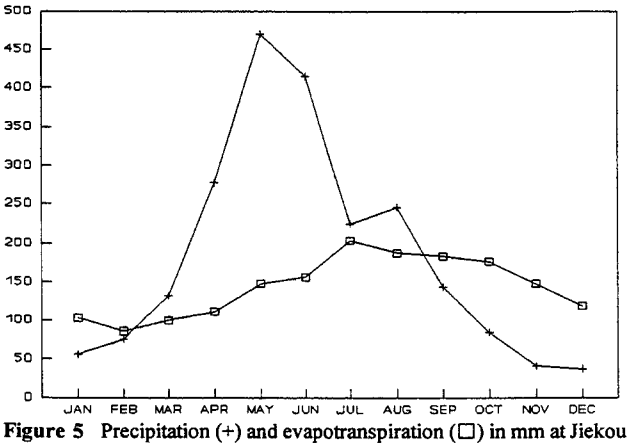


Figure 5 Precipitation (+) and evapotranspiration (□) in mm at Jiekou meteorological station.

Low mountains dominate the area and three subregions are identified:

* the western section: mainly NE-SW tending with peaks at about 2000 m a.s.l.
* the middle section: mainly W-E tending, with peaks at about 1000 m a.s.l.
* the eastern section: generally below 1000 m a.s.l.

2.4 Vegetation and land use

Subtropical evergreen broad-leaved forest grows luxuriantly. Subtropical timber and economic crops like oil-tea, tung oil tree, citrus, lychee and longan are the main agricultural crops (Zhao Qiguo, 1988). In some areas, forests have been felled resulting in soil erosion and flooding of the lower areas. Therefore, reforestation and prohibition of uncontrolled felling of trees on mountain lands is recommended to preserve the ecological environment of the region. Only healthy watershed areas can assure regular and sufficient water supply for the downstream agricultural areas. High yielding agriculture in intermontane basins depends on a large supply of irrigation water (Zhao Songqiao, 1986).

3 THE REFERENCE SOILS

3.1 The relation between the studied sites

In this chapter a selection of data and research information of reference soils CN 29, 31 and 32 are discussed. The location and number of the 3 profiles is presented in Fig. 6.
Comprehensive field and laboratory data are given in Annex 1A, 1B and 1C: Soil and environmental data, stored in ISRIC Soil Information System (Van Waveren & Bos, 1988).

3.2 Location

The 3 profiles are located in the Quingyun Mountains at 100-150 km NNE from Guangzhou (Canton), the provincial capital of Guangdong. Reference soil CN 29 is located at an elevation of about 600 m a.s.l. in Wengyuan County, near Shen Menai along the road from Wengyuan to Fengcheng. The distance from Wengyuan to the profile site is about 10 km. Reference soil CN 31 is located at approximately 250 m a.s.l., near Beitou, at 1 km to the south, along the road from Wengyuan to Lianping. Reference soil CN 32 is situated more to the south, near the village of Wenquan. It lies at an elevation of 250 m a.s.l. The profile is located at km 2 on the road from Jiekou (Conghua) to Fengsheng (Xinfeng).

3.3 Physiography, parent material and natural vegetation

The landscape around CN 29 has a strongly dissected topography with summits of about 1000 m a.s.l. and with deeply incised V-shaped valleys. Slopes are covered by colluvial material, consisting of stony material overlying weathered or fresh shales at various depths. Quartz veins in the shales stand out and form locally steep slopes. Intermontane basins are associated with some of the important drainage ways but they are of limited extent.
Landforms around CN 31 are to a large extent determined by (sub)tropical karst weathering. The mountains stand out as karst towers (see photo 4) rising steeply above the flat basins. Slopes are steep and numerous outcrops of crystalline limestone occur. Therefore, on the slopes, the soils have varying depths.
The area around CN 32 is characterised by rounded low hills on deeply weathered granite. The lower slopes are locally covered with colluvium.
The natural vegetation changes with altitude. In the hills where CN 29 and CN 31 were studied, a (semi) natural vegetation of semi deciduous woodland and evergreen shrub is dominant. Masson pine, Chinese fir, bamboo and ferns are characteristic for the evergreen forest around site CN 32.

3.4 Soil characterization

3.4.1 Brief field description

CN 29 is a moderately deep, well drained, dark yellowish brown to strong brown silty clay, which is moderately well structured. At 70 cm depth, a buried soil profile is found with strong brown silt loam, containing rock fragments. Soil depth varies over short distances.
CN 31 is a deep, well drained, yellowish red to dark reddish brown, gravelly to stony clay; strongly structured. In the subsoil clay accumulation and clay cutans are observed. At short distances, profile depth and stoniness are highly variable.
CN 32 is a deep, well drained, dark yellowish brown to dark brown, sandy clay; moderately structured, developed in colluvium overlying a buried profile, developed in residual material, from granite. The buried profile is dark yellowish brown to yellowish red, clayey and shows evidence of clay illuviation in the subsoil.

3.4.2 Brief analytical characterizations

Bulk soil samples were analyzed by ISSAS and ISRIC. Undisturbed core samples were analyzed by ISRIC. Procedures of the ISRIC laboratory are described by Van Reeuwijk (1992). The analytical data are presented in Annex 1A, 1B and 1C.

Table 1 gives the classification of some key properties (ISRIC, in prep.; Landon, 1991).
Some important soil data were selected and presented in a graphical way using SOLGRAPH (Brunt & Kauffman, 1995).
Fig. 7, 8 and 9 show the textural distribution of the three soils with depth. The clay content of soil CN 29 is decreasing with depth both in the recent and the buried profile, while the sand content is increasing. The clay content of soil CN 31 shows an increase (argic horizon) in the subsoil. The sand content is constant with depth. The silt content of soil CN 32 is increasing with depth. Sand and clay content are highly variable. In the deep subsoil, the clay content sharply decreases.

Fig. 10, 11 and 12 present chemical properties with depth: the organic C content, the sum of the exchangeable bases (Ca, Mg, K and Na), and soil acidity (pH-H_2O and pH-KCl). The sum of the exchangeable bases of soil CN 29 is very low throughout the profile. The organic C content decreases with depth and the pH increases. The organic C content of CN 31 decreases with depth and the pH does not change widely. The topsoil of the recent profile and the deeper subsoil, have a higher sum of exchangeable bases in comparison with the rest of the profile. The pH is not fluctuating in soil profile CN 32. The organic C content and the sum of the exchangeable bases decrease with depth.

Table 1 Key properties of soils CN 29, 31 and 32

	CN 29	CN 31	CN 32
Texture	silty clay in the top layers, (silt) loam in the buried soil	clay throughout the profile	sandy clay in the top layers to clay in the buried profile
Organic carbon	high (3.1%) in the topsoil	high (4.2%) in the topsoil, medium (1.6%) in the lower topsoil	high (2.9%) in the topsoil to medium (1.4%) in the lower topsoil
Acidity	strongly acid (pH-H_2O 4.1) in both the recent and the buried profile	neutral (pH-H_2O 6.1) in the topsoil and (slightly) acid in the subsoil (pH-H_2O 4.9- 5.9)	strongly acid (pH-H_2O 4.3) throughout the profile
Sum of bases	very low (< 1 $cmol_c\ kg^{-1}$ soil) throughout the profile	very high (± 21 $cmol_c\ kg^{-1}$ soil) in the topsoil and high (8 $cmol_c\ kg^{-1}$ soil) in the subsoil	low (± 2 $cmol_c\ kg^{-1}$ soil) in the topsoil to very low (< 1 $cmol_c\ kg^{-1}$ soil) in the deeper profile
Cation Exchange Capacity	medium (± 15 $cmol_c\ kg^{-1}$ soil) in the topsoil to low (± 8 $cmol_c\ kg^{-1}$ soil) in the subsoil	high (± 25 $cmol_c\ kg^{-1}$ soil) in the topsoil and medium (± 15-20 $cmol_c\ kg^{-1}$ soil) in the subsoil	medium (11 $cmol_c\ kg^{-1}$ soil) in the topsoil to low (7 $cmol_c\ kg^{-1}$ soil) in the deeper profile
Exch. aluminium	high (± 50%) in the topsoil to very high (± 75%) in the subsoil		moderate (30%) in the topsoil to high (> 50%) in the deeper profile
Phosphorus	very low (0.6 mg kg^{-1}) in the topsoil	very low (0.7 mg kg^{-1}) in the topsoil	
Nitrogen	medium (0.18%) in the topsoil, very low in the deeper profile	very high (0.34%) in the topsoil, medium in the deeper profile	
Clay mineralogy	kaolinite and mica/illite	chlorite	kaolinite
Air capacity	medium (14%) in the topsoil and slowly decreasing with depth	low (9%) in the topsoil and very low (3%) in the subsoil	low (10%) in the subsoil
Available soil moisture	very high (22%) in the topsoil to medium in the subsoil	low (8%) throughout the profile	low (7%) in the subsoil
Bulk density	very low (0.7 kg dm^{-3}) in the topsoil to medium (1.3 kg $dm_{,3}$) in the subsoil	high (1.4 kg dm^{-3}) throughout the profile	medium (1.3 kg dm^{-3}) in the subsoil

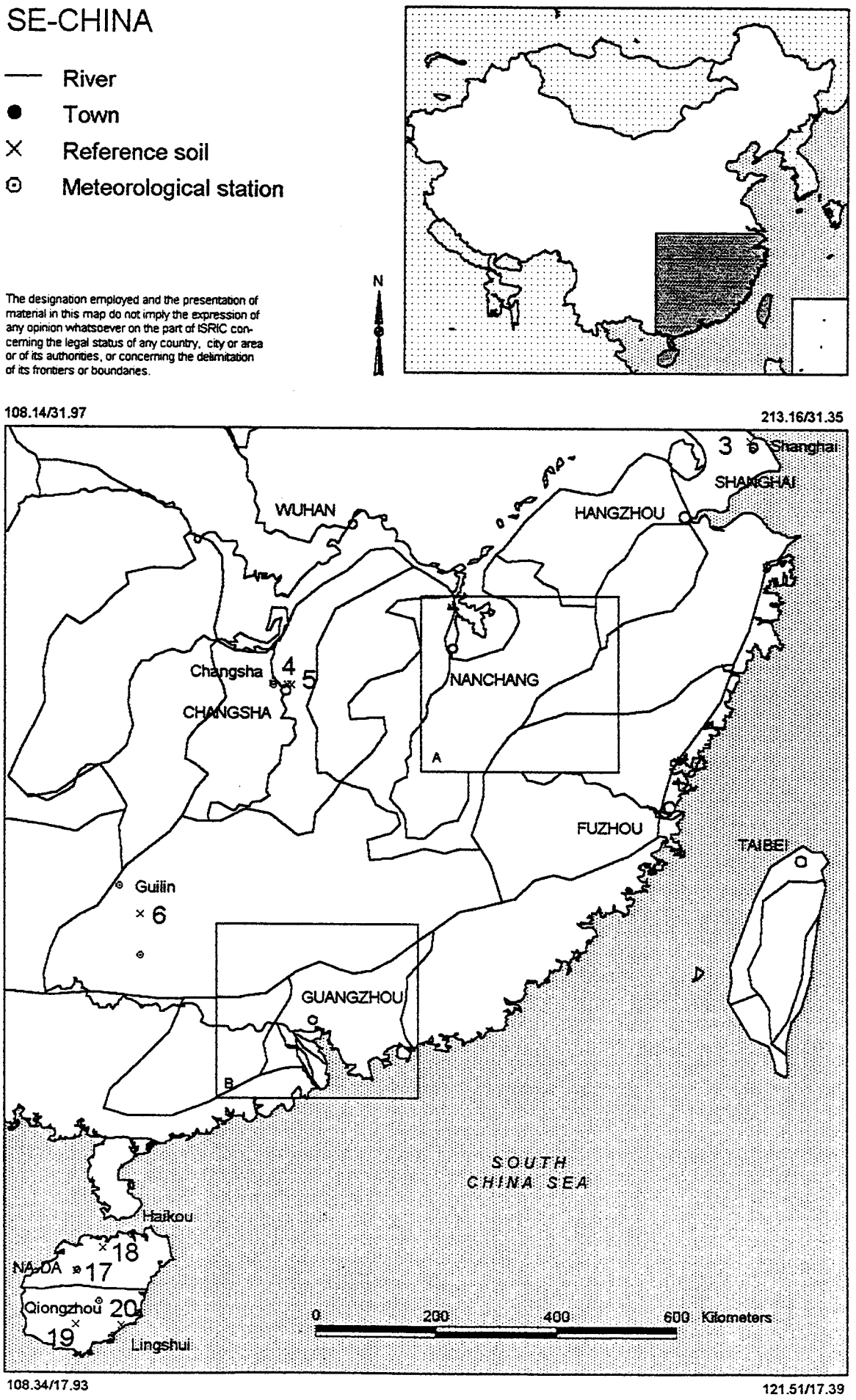
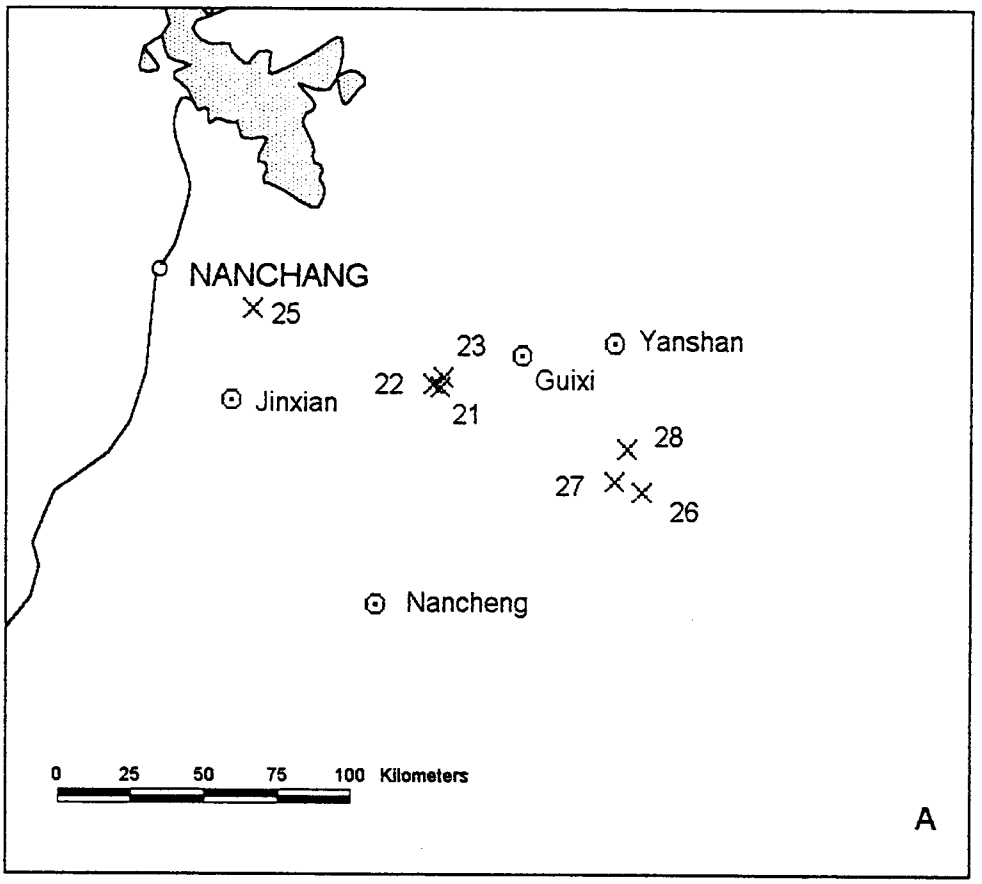


Figure 6 Location and numbers of the reference soils.



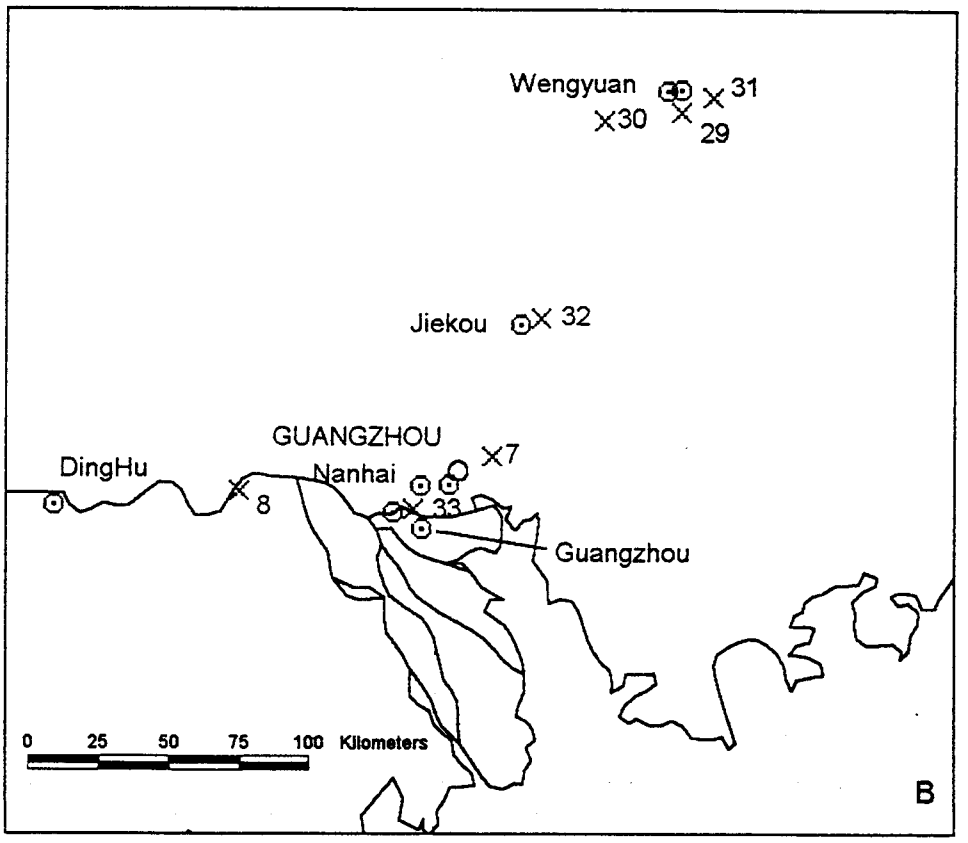


Figure 6a Detail of location map.

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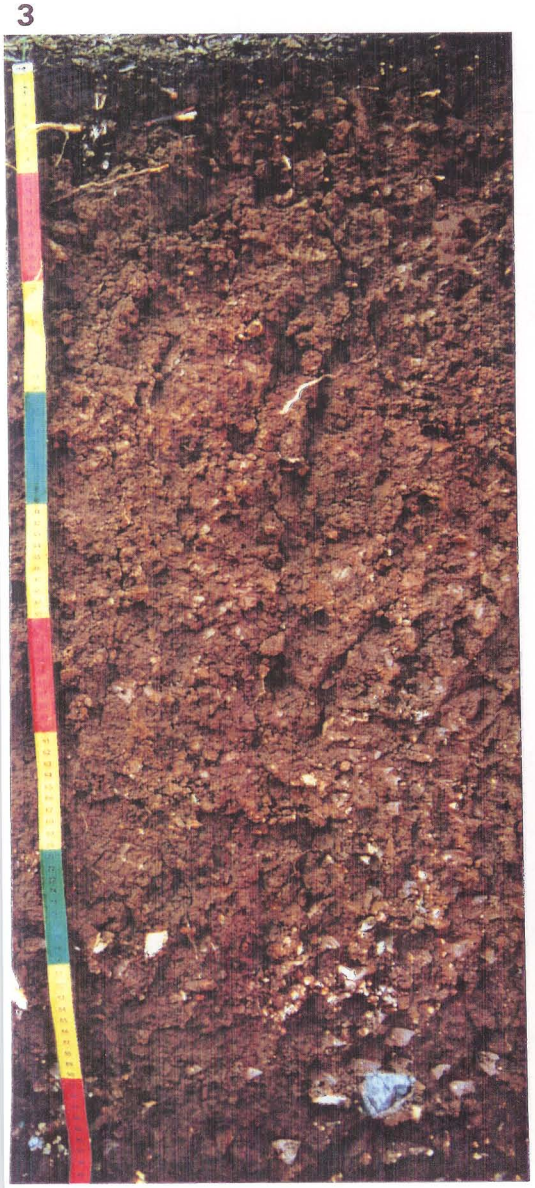
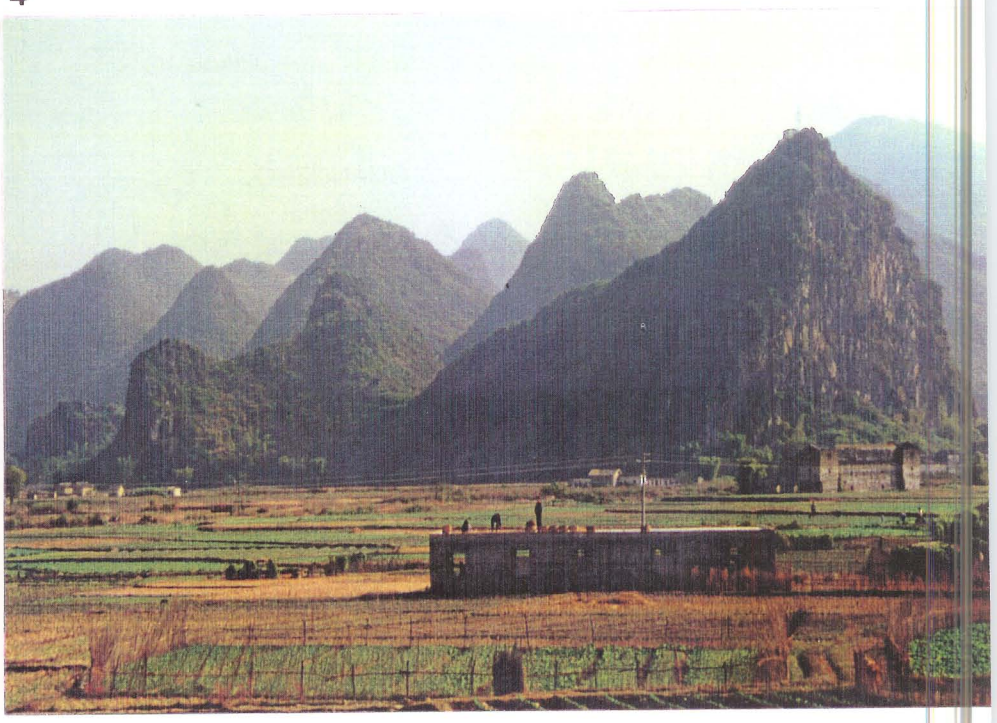
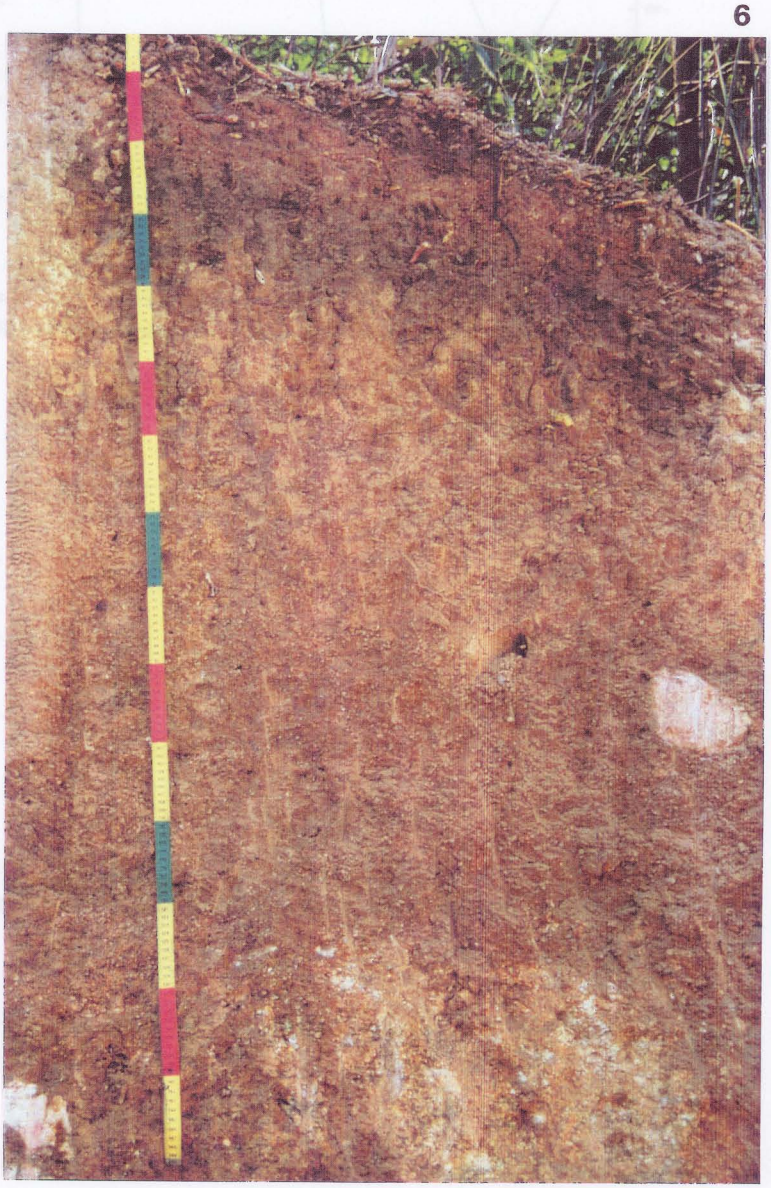


4



5

6



1. Landscape CN 29
2. Profile CN 29

3. Landscape CN 31
4. Profile CN 31

5. Landscape CN 32
6. Profile CN 32

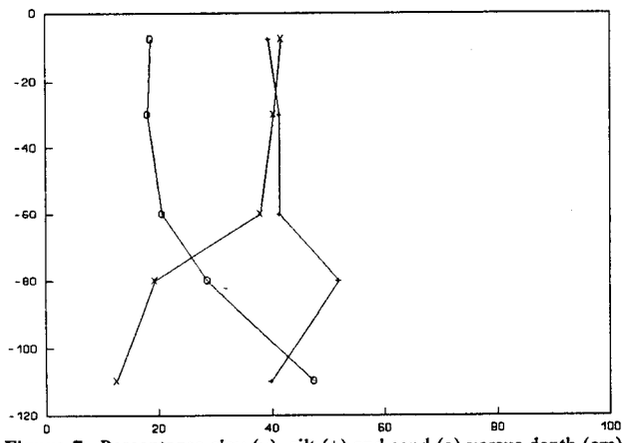


Figure 7 Percentages clay (×), silt (+) and sand (o) versus depth (cm) in profile CN 29.

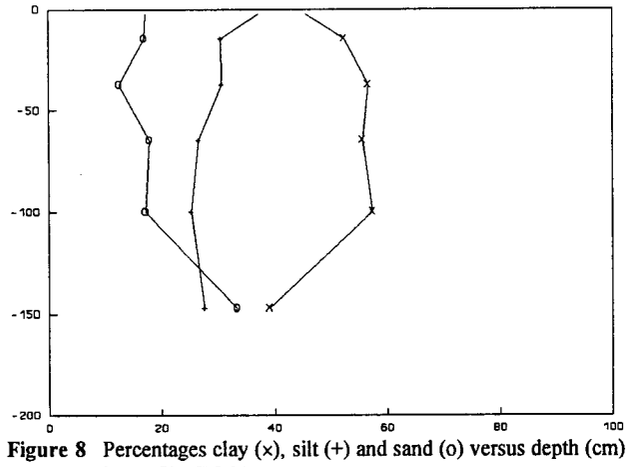


Figure 8 Percentages clay (×), silt (+) and sand (o) versus depth (cm) in profile CN 31.

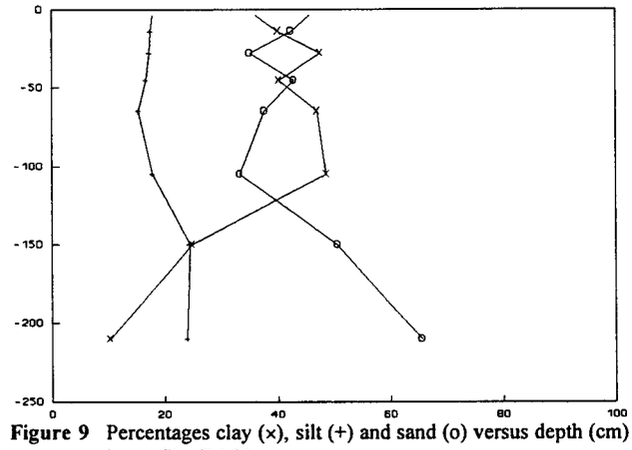


Figure 9 Percentages clay (×), silt (+) and sand (o) versus depth (cm) in profile CN 32.

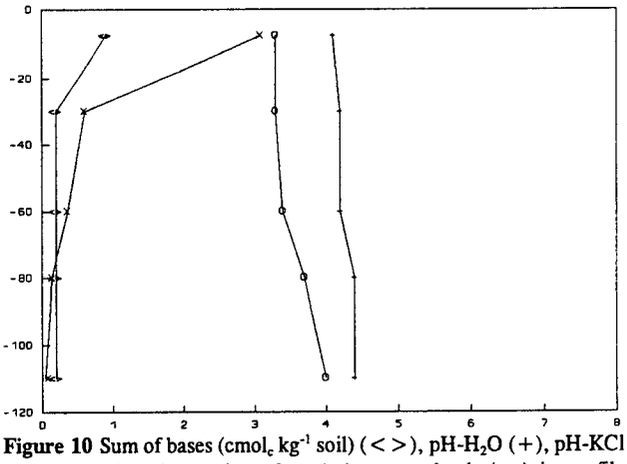


Figure 10 Sum of bases ($cmol_c\ kg^{-1}$ soil) (< >), pH-H_2O (+), pH-KCl (o) and organic carbon (×) versus depth (cm) in profile CN 29.

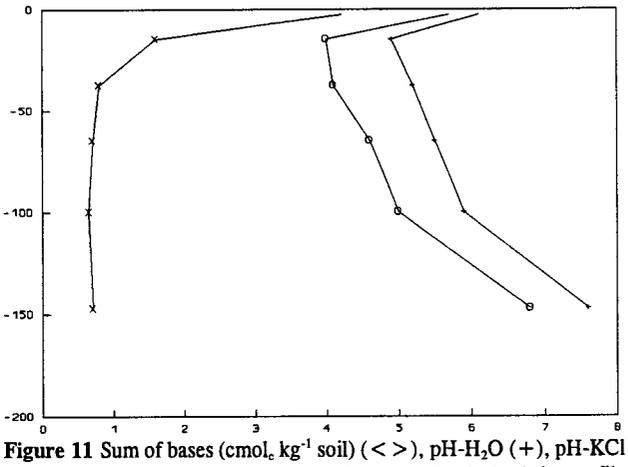


Figure 11 Sum of bases ($cmol_c\ kg^{-1}$ soil) (< >), pH-H_2O (+), pH-KCl (o) and organic carbon (×) versus depth (cm) in profile CN 31.

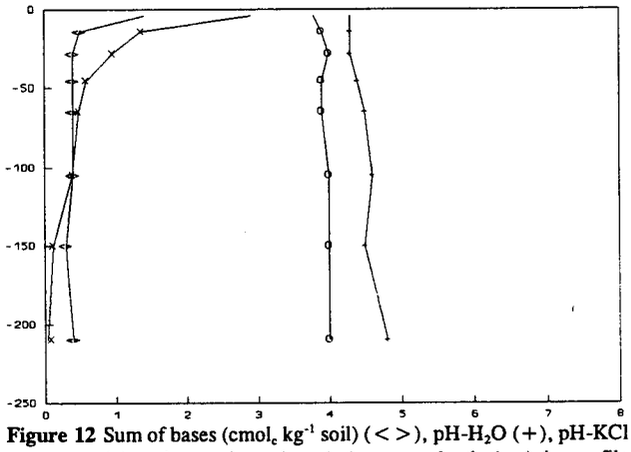


Figure 12 Sum of bases ($cmol_c\ kg^{-1}$ soil) (< >), pH-H_2O (+), pH-KCl (o) and organic carbon (×) versus depth (cm) in profile CN 32.

Fig. 13, 14 and 15 present the moisture retention curves (pF graphs). The intersection point with the x-axis gives the water content of the soils under saturated conditions which indicates the total pore-volume. The quantity of soil moisture between pF 0 and pF 2 is expressed by the air capacity which is a measure for the drainage and aeration conditions of a soil. The available soil moisture (ASM) is the quantity of moisture between pF 2 (field capacity) and pF 4.2 (permanent wilting point).
The available soil moisture, the total pore volume and the air capacity of soil CN 29 are higher in the topsoil than in the subsoil. However, the topsoil was sampled by taking the first few centimetres of the profile, which can retain more water and has a better developed structure. The structure of the topsoil of soil CN 31 is better developed than the subsoil which is expressed by the higher total pore volume. The air capacity is decreasing with depth and the available soil moisture is rather constant with depth. Soil CN 32 of which only one horizon of the buried profile was sampled, has a low air capacity and available soil moisture due to its clayey texture.

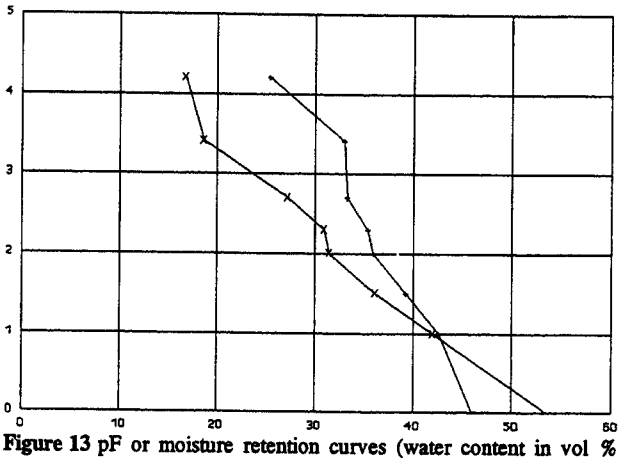


Figure 13 pF or moisture retention curves (water content in vol % versus suction) at depth 0-15 cm (×), 50-70 cm (+) in profile CN 29.

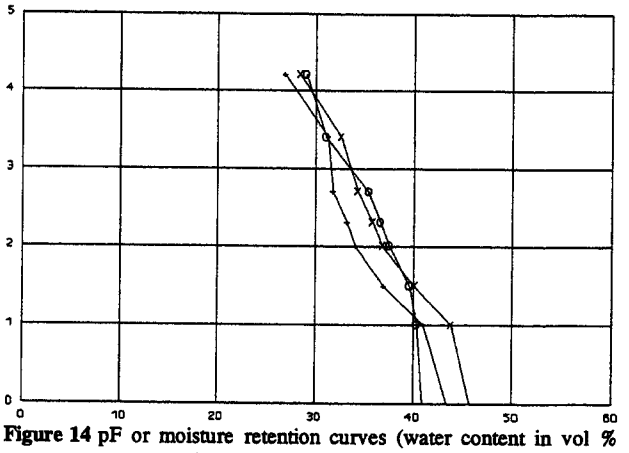


Figure 14 pF or moisture retention curves (water content in vol % versus suction) at depth 10-20 cm (×), 25-50 cm (+), 90-110 cm (o) in profile CN 31.

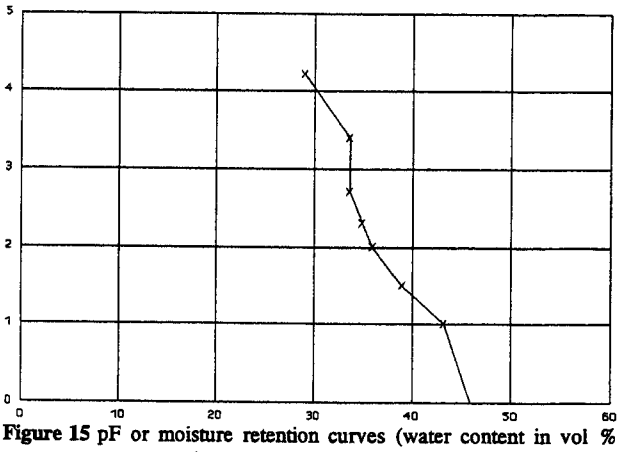


Figure 15 pF or moisture retention curves (water content in vol % versus suction) at depth 55-75 cm (×) in profile CN 32.

3.5 Soil classification

3.5.1 Soil classification of CN 29

FAO-Unesco (1988)
The soil classifies as a Ferralic Cambisol, because the soil has a cambic B horizon and no diagnostic horizons other than an ochric A horizon. The colour of the A horizon is too light and the base saturation is < 50% so it can not be classified as a mollic horizon. The base saturation between 20 and 50 cm from the surface is also < 50% and the CEC is < 24 $cmol_c\ kg^{-1}$ clay in at least some part of the cambic B horizon. The soil lacks vertic and gleyic properties.

USDA Soil Taxonomy (1992)
The soil classifies as a Typic Dystrochrept because it has a cambic B horizon and an ochric epipedon. The soil moisture regime is udic and the base saturation between 25 and 75 cm from the mineral soil surface is < 60%. The soil does not have a fragipan, duripan or a sulfuric horizon.

Chinese Soil Taxonomic Classification System (1993)
The soil belongs to the suborder of Udic Fersiallisols. The B horizon has a hue of 7.5YR and a base saturation of < 35%. There is no detrital limestone or weathering residual lime, or lithic contact of limestone within 100 cm of the surface. The CEC of the fine-earth divided by the clay percentage is < 0.4. The soil has an ochrihumic epipedon, no humic property, neither argillic horizon nor agric horizon, neither redoxic nor gleyic features and is classified as a Haplic Para-Red Soil.

3.5.2 Soil classification of CN 31

FAO-Unesco (1988)
An illuvial B horizon is found, which meets the requirements of an argic B horizon because it has more than 8% clay increase in comparison to the overlying horizon, and clay cutans are observed. The thickness of the overlying A horizon is questionable. The CEC is >24 $cmol_c\ kg^{-1}$ clay and the base saturation is > 50% throughout the B horizon. The colour is dark reddish brown. The soil keys out as a Chromic Luvisol.
The clay distribution does show a relative decrease of > 20% within 150 cm of the surface. The boundary between A and B horizon is gradual and nitic properties are observed.

USDA Soil Taxonomy (1992)
The soil has an argillic horizon with a base saturation of > 35%. The soil moisture regime is udic and a relative clay decrease with increasing depth of 20% or more from the maximum clay content is observed. Therefore the soil does not key out as a Paleudalf but as a Typic Hapludalf.

Chinese Soil Taxonomic Classification System (1993)
The soil belongs to the suborder of Udic Fersiallisols. The B horizon has a hue of 5YR and the soil has weathered residual lime within 100 cm of the surface. Some subhorizon with a thickness of > 10 cm has a base saturation of >35%. It has an ochrihumic epipedon, but not a humic property, nor a base saturation of ≥ 80%. The soil keys out as a Luvic Brown Limestone Soil.

3.5.3 Soil classification of CN 32

The first 20 cm consist of colluvial material which was deposited on the profile. For classification purposes this deposit is not taken into account and the buried profile is classified.

FAO-Unesco (1988)
The soil classifies as a Ferralic Cambisol, having an ochric A horizon (too light in colour, too low base saturation to be a mollic or umbric A horizon) and a cambic B horizon with ferralic properties (CEC < 24 $cmol_c\ kg^{-1}$ clay in at least some subhorizon of the cambic B horizon). Is does not show vertic or gleyic properties. The B horizon is not classified as an argic B horizon, because there is not enough clay accumulation. The soil does not meet all the requirements of a ferralic B-horizon since the silt-clay ratio is too high (± 0.3). The CEC clay in the whole profile is, however, < 16 $cmol_c\ kg^{-1}$.

USDA Soil Taxonomy (1992)
The soil has an oxic horizon that has its upper boundary within 150 cm of the mineral soil surface. The B horizon is oxic due to its thickness of ≥ 30 cm, its low content of weatherable minerals, its low CEC (< 16 $cmol_c\ kg^{-1}$ clay) and the diffuse upper particle size boundary (< 20% within a vertical distance of 15 cm). The soil has a udic soil moisture regime. ≥ 50% of the hue of the soil is 7.5YR and the value, moist is 5, which is one unit too low to be classified as a Xanthic Hapludox. The lower boundary of the oxic horizon is found at 130 cm which does not match with the criteria of an Inceptic Hapludox. Therefore the soil keys out as a Typic Hapludox.

Chinese Soil Classification System (Soil Taxonomic Classification Research Group, 1993)
The soil belongs to the suborder of the Udic Ferrallisols. It has an umbrihumic epipedon, a base saturation of < 35%, does not have redoxic features nor a humic property and does not show an argic horizon neither an argillic horizon whose upper boundary is within 125 cm of the surface. The B horizon has a thickness of ≥ 10 cm and its upper boundary is within 50 cm of the surface. The CEC of fine earth/clay < 0.16 and its ECEC of fine earth/clay < 0.12. The soil keys out as a Haplic Latored Soil. In case the soil moisture regime is considered as perudic, the classification changes into Latored Yellow Soil.

3.6 Soil suitability

This region is mainly consisting of low mountains with an altitude of more than 250 m a.s.l. The utilization of these soils for arable use is seriously limited by the slope factor, which is directly related to the erosion hazard.
Forestry and the processing of its products have to be stimulated, environmental degradation has to be prevented. Tree felling should be combined with replanting to maintain the protective tree cover. Overfelling should be prohibited in areas where the erosion hazard is high.

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Annex 1A ISIS Data Sheet CN 29

ISIS 4.0 data sheet of monolith CN 29 Country : PEOPLE'S REPUBLIC OF CHINA Print date (dd/mm/yy) : 01/06/94

FAO/UNESCO (1988) : Alumi-Ferralic Cambisol (Chromic) (1974 : Ferralic Cambisol)
USDA/SCS SOIL TAXONOMY (1992) : Typic Dystrochrept, fine, mixed, thermic (1975 : Typic Dystrochrept)
CSTC (1991) : Haplic para-red soil

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, cambic B horizon; ferralic properties
USDA/SCS (1992) : ochric epipedon, cambic horizon
Soil moisture regime : udic

LOCATION : Wengyuan county, Shen Menai, 10km on road Wengyuan-Fengcheng
Latitude : 24°17′ 0′′ N Longitude : 114°11′ 0′′ E Altitude : 600 m a.s.l.
AUTHOR(S) : Luo/ Van Engelen, V./ Zhang Date (mm/yy) : 11/92

GENERAL LANDFORM : mountain Topography : mountainous
PHYSIOGRAPHIC UNIT : higher part lower montains
SLOPE Gradient : 30% Aspect : NNE Form : complex
POSITION OF SITE : middle slope
MICRO RELIEF Kind :
SURFACE CHAR. Rock outcrop : nil Stoniness : nil
Cracking : small cracks Slaking/crusting : nil
Salt : nil Alkali : nil
SLOPE PROCESSES Soil erosion : slight gully Aggradation : not apparent
Slope stability : locally unstable

PARENT MATERIAL 1 : colluvium derived from : shale
Texture : clayey
Weathering degree : high
2 : residual material derived from : shale
Texture : clayey
Weathering degree : high Resistance : moderate
Depth lithological boundary : 70 cm
Remarks : Devonian shale

EFFECTIVE SOIL DEPTH : 150 cm

WATER TABLE : no watertable observed
DRAINAGE : well
PERMEABILITY : moderate; no slowly permeable layer(s)
FLOODING Frequency : nil Run off : rapid
MOISTURE CONDITIONS PROFILE : 0 - 90 cm dry 90 - 120 cm moist

LAND USE : (semi-) natural vegetation (Masson pine, fir, bamboo, fern)
VEGETATION Type : semi deciduous woodland Status : secondary

ADDITIONAL REMARKS :
Soil can vary in depth over short distances. In places less than 50cm on more eroded sites (steeper slopes) or on more resistant facies of shale. Pockets of strongly weathered shale occur side-by-side in the R horizon. It is assumed that the moderately weathered stones occuring in the 2Bt horizon are the result of colluvial action, hence the two parent materials.

Slide nos. of the ISRIC collection: 13917-13921 (landscape,profile, profile details, monolith taking)

CLIMATE : Köppen: Cw
Station: WENGYUAN 24 22 N/114 29 E 215 m a.s.l. 32 km SSE of site Relevance: moderate

		No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
pan evaporation	mm	26	79	67	80	98	116	124	174	163	151	139	112	88	1388
relative humidity	%	27	73	78	81	82	84	85	81	82	80	75	72	72	79
precipitation	mm	27	51	81	131	219	327	334	183	195	115	61	36	41	1773
no. of raindays		27	10	13	16	17	21	20	17	18	12	7	6	8	163
T mean	°C	27	10.1	11.6	15.7	20.2	23.9	25.7	27.1	26.8	25.1	20.9	16.2	12.0	19.6
T max	°C	27	16.4	16.9	20.6	24.8	28.4	30.3	32.7	32.4	30.6	27.1	22.8	18.6	25.1
T min	°C	27	6.0	8.0	12.2	16.9	20.7	22.6	23.3	23.2	21.3	16.5	11.7	7.6	15.9
windspeed(at 2m)	m s^{-1}	27	1.3	1.3	1.1	1.0	0.9	0.9	1.0	0.8	1.0	1.2	1.4	1.4	1.1
bright sunshine	h d^{-1}	26	4.0	3.0	2.6	2.8	3.4	4.1	6.8	6.6	5.8	5.6	5.5	4.8	4.6
bright sunshine	%	26	37	26	21	22	26	31	51	49	48	49	49	44	38

ISIS 4.0 data sheet of monolith CN 29 Country : PEOPLE'S REPUBLIC OF CHINA Print date (dd/mm/yy) : 01/06/94

PROFILE DESCRIPTION :
Moderately deep, well drained, strong brown clay derived from Devonian shale. The dark yellowish brown topsoil has moderately developed subangular blocky structures and has a high organic carbon content. The subsoil is strongly angular blocky, becoming stony below 70 cm depth. Soil reaction is strongly acid throughout.

Ah 0 - 15 cm Dark yellowish brown (10YR 4/6, moist) to yellowish brown (10YR 5/6, dry) clay loam; moderate subangular blocky structure; slightly sticky, slightly plastic, friable, hard; common fine to medium continuous exped vesicular pores; highly porous; many very fine and fine roots throughout; frequent worm channels; clear wavy boundary to

Bt 15 - 70 cm Strong brown (7.5YR 5/6, moist) to reddish yellow (7.5YR 6/8, dry) clay; very strong very coarse angular blocky parting to strong medium to coarse angular blocky structure; very sticky, very plastic, firm, very hard; continuous moderately thick clay and sesquioxide cutans on pedfaces; few to common very fine to fine continuous inped tubular pores; slightly porous; common very fine roots throughout; few channels; clear wavy boundary to

2Bt 70 - 90 cm Strong brown (7.5YR 5/6, moist) to reddish yellow (7.5YR 6/8, dry) stony clay; very strong to strong coarse angular blocky structure; very sticky, very plastic, firm, very hard; broken moderately thick clay and sesquioxide cutans on pedfaces; few very fine to fine continuous inped tubular pores; slightly porous; few very fine roots throughout; frequent medium strongly weathered shale fragments; no biological activity; clear irregular boundary to

R 90 - 120 cm Strong brown (7.5YR 5/6, moist) clay; sticky, slightly plastic, friable; few very fine roots throughout; frequent medium strongly weathered rotten shale fragments; no biological activity

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pF- 0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2
1	0 - 15	-	0	1	1	5	12	19	19	20	40	42	-	0.73	54	42	36	32	31	27	19	17
2	20 - 40	-	0	1	1	8	9	18	12	30	41	40	-	-	-	-	-	-	-	-	-	-
3	50 - 70	-	1	1	2	6	11	21	12	30	41	38	-	1.30	46	43	39	36	36	33	33	25
4	70 - 90	-	1	2	3	13	10	29	16	36	52	19	-	-	-	-	-	-	-	-	-	-
5	100 - 120	-	1	4	7	18	17	48	11	29	40	13	-	-	-	-	-	-	-	-	-	-

Hor. no.	pH- H2O	KCl	CaCO3 %	ORG- C %	MAT. N %	EXCH CAT. Ca	Mg	K	Na	sum	EXCH AC. H+Al	Al	CEC soil	clay	OrgC	ECEC	BASE SAT %	Al SAT %	EC 2.5 mS cm^{-1}
						cmol$_c$ kg^{-1}													
1	4.1	3.3	-	3.09	0.18	0.8	0.0	0.1	0.0	0.9	8.2	7.9	15.3	37	10.8	9.1	6	52	0.05
2	4.2	3.3	-	0.60	0.06	0.2	0.0	0.0	0.0	0.2	5.2	4.9	6.5	16	2.1	5.4	3	75	0.02
3	4.2	3.4	-	0.36	0.05	0.2	0.0	0.0	0.0	0.2	3.5	3.4	8.8	23	1.3	3.7	2	39	0.02
4	4.4	3.7	-	0.14	0.04	0.2	0.0	0.0	0.0	0.2	2.4	2.2	3.7	19	0.5	2.6	5	59	0.01
5	4.4	4.0	-	0.05	0.02	0.2	0.0	0.0	0.0	0.2	1.6	1.4	2.5	20	0.2	1.8	8	56	0.01

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe & Al (by Na DITHIONITE) / AVAIL. P (Bray)

Hor. no.	MICA /ILL	VERM	CHLOR	KAOL	MIX	GOET	Fe	Al	P mg kg^{-1}
1	4	1	2	4	3	2	1.6	0.3	0.6
2	4	2	3	4	3	3	1.9	0.3	0.0
3	4	3	3	4	3	3	2.0	0.3	0.0
4	4	2	3	4	2	3	1.7	0.2	0.0
5	4	2	2	4	2	4	1.6	0.2	0.0

Annex 1B ISIS Data Sheet CN 31

ISIS 4.0 data sheet of monolith CN 31 Country : PEOPLE'S REPUBLIC OF CHINA Print date (dd/mm/yy) : 01/06/94

FAO/UNESCO (1988) : Eutri-Haplic Nitisol (Chromic) (1974 : Chromic Luvisol)
USDA/SCS SOIL TAXONOMY (1992) : Typic Hapludalf, fine, mixed, thermic (1975 : Mollic Hapludalf)
CSTC (1991) : Luvic brown limestone soil

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, argic B horizon; nitic properties
USDA/SCS (1992) : ochric epipedon, argillic horizon
Soil moisture regime : udic

LOCATION : Lianping, Beitou, 1km south of main road Wengyuan-Lianping
Latitude : 24°23' 0'' N Longitude : 114°17' 0'' E Altitude : 250 m a.s.l.
AUTHOR(S) : Luo/ Van Engelen, V./ Zhang Date (mm/yy) : 11/92

GENERAL LANDFORM : mountain Topography : mountainous
PHYSIOGRAPHIC UNIT : tower karst mountains
SLOPE Gradient : 100% Aspect : ENE Form : straight
POSITION OF SITE : lower slope
MICRO RELIEF Kind :
SURFACE CHAR. Rock outcrop : rocky Stoniness : very few stones
Form : (sub)rounded Average size : 10 cm
Cracking : nil Slaking/crusting : nil
Salt : nil Alkali : nil
SLOPE PROCESSES Soil erosion : slight sheet Aggradation : nil
Slope stability : stable

PARENT MATERIAL : residual material derived from limestone (grey marble)
Texture : clayey
Weathering degree : slight Resistance : very high

EFFECTIVE SOIL DEPTH : 165 cm

WATER TABLE : no watertable observed
DRAINAGE : well
PERMEABILITY : high; no slowly permeable layer(s)
FLOODING Frequency : nil Run off : slow
MOISTURE CONDITIONS PROFILE : 0 - 50 cm dry 50 - 165 cm moist

LAND USE : (semi-)natural vegetation; some isolated fir and pine trees
VEGETATION Type : evergreen shrub Status : degraded

ADDITIONAL REMARKS :
Landform: steep mountains (tower karst-like) with a great variety in soil depth. Rock outcrops occur alongside deep soils. In the soil great boulders of marble occur. They have a typical solution surface with smooth curves. The soil itself doesn't seem to have free carbonates.
The lower slope has hardly any colluvial material and the is a sharp transition from the straight slope to the flat intermontane basin.
Soils: apart from the dominant red coloured soils some browner ones occur on the lower slopes. Also a violet B horizon was found next to a red soil. Apart from an irregular depth also the content of stones varies from place to place.

Slide nos. of the ISRIC collection: 13934-13944 (landscape, profile, profile details, monolith taking).

CLIMATE : Köppen: Cw
Station: WENGYUAN 24 22 N/114 29 E 215 m a.s.l. 20 km ENE of site Relevance: moderate

		No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
pan evaporation	mm	26	79	67	80	98	116	124	174	163	151	139	112	88	1388
relative humidity	%	27	73	78	81	82	84	85	81	82	80	75	72	72	79
precipitation	mm	27	51	81	131	219	327	334	183	195	115	61	36	41	1773
no. of raindays		27	10	13	16	17	21	20	17	18	12	7	6	8	163
T mean	°C	27	10.1	11.6	15.7	20.2	23.9	25.7	27.1	26.8	25.1	20.9	16.2	12.0	19.6
T max	°C	27	16.4	16.9	20.6	24.8	28.4	30.3	32.7	32.4	30.6	27.1	22.8	18.6	25.1
T min	°C	27	6.0	8.0	12.2	16.9	20.7	22.6	23.3	23.2	21.3	16.5	11.7	7.6	15.9
windspeed(at 2m)	$m\ s^{-1}$	27	1.3	1.3	1.1	1.0	0.9	0.9	1.0	0.8	1.0	1.2	1.4	1.4	1.1
bright sunshine	$h\ d^{-1}$	26	4.0	3.0	2.6	2.8	3.4	4.1	6.8	6.6	5.8	5.6	5.5	4.8	4.6
bright sunshine	%	26	37	26	21	22	26	31	51	49	48	49	49	44	38

ISIS 4.0 data sheet of monolith CN 31 Country : PEOPLE'S REPUBLIC OF CHINA Print date (dd/mm/yy) : 18/05/94

PROFILE DESCRIPTION :
Deep, well drained, dark reddish brown clay derived from grey marble. The thin but dark coloured topsoil has a strongly developed subangular blocky structure, while in the remaining soil strong angular blocky structures prevail. The organic carbon content is medium, averaged over the first 25 cm. Soil reaction is acid in the first 50 cm, becoming slightly acid below and neutral to slightly alkaline near the only slightly altered rock.

Ah 0 - 5 cm Dark brown (10YR 3/3, moist; 10YR 4/3, dry) slightly gravelly clay loam; strong very fine to fine subangular blocky structure; sticky, plastic, very firm, very hard; common fine to medium continuous exped vesicular pores; highly porous; many fine roots throughout and common medium roots between peds; very few fine fresh marble fragments; frequent worm channels and coprogenic elements; clear smooth boundary to

AB 5 - 24 cm Yellowish red (5YR 4/6, moist) to strong brown (7.5YR 4/6, dry) slightly gravelly clay; moderate to strong medium to coarse angular blocky parting to strong fine to medium angular blocky structure; very sticky, very plastic, very firm, extremely hard; patchy thin clay cutans on pedfaces; common fine continuous inped tubular pores; moderately porous; common fine and medium roots throughout; very few medium fresh marble fragments; frequent worm channels; gradual smooth boundary to

Bt1 24 - 51 cm Dark reddish brown (5YR 3/4, moist; 5YR 3/6, dry) slightly stony clay; very strong coarse angular blocky parting to strong fine to medium angular blocky structure; very sticky, very plastic, very firm, extremely hard; continuous thick clay cutans on pedfaces; few very fine to fine continuous inped tubular pores; slightly porous; common fine and medium roots throughout; few medium fresh marble fragments; few worm channels; gradual smooth boundary to

Bt2 51 - 120 cm Dark reddish brown (5YR 3/6, moist) bouldery clay; very strong coarse angular blocky parting to strong fine to medium angular blocky structure; very sticky, very plastic, very firm; continuous thick clay cutans on pedfaces; few very fine to fine continuous inped tubular pores; slightly porous; few fine roots throughout; few extremely coarse fresh marble fragments; few worm channels

Auger 120 - 165 cm Dark yellowish brown (5YR 3/6, moist) bouldery clay; very sticky, very plastic, very firm; slightly porous; no roots

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pF- 0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2
1	0 - 5	-	2	2	3	5	6	17	9	28	37	46	16.5	-	-	-	-	-	-	-	-	-
2	10 - 20	-	4	2	2	5	4	17	11	20	31	52	29.8	1.35	46	44	40	37	36	34	33	28
3	25 - 50	-	2	2	2	3	4	13	8	22	31	57	35.8	1.31	43	41	37	34	33	32	31	27
4	55 - 75	-	5	3	2	4	3	18	7	20	27	56	37.2	-	-	-	-	-	-	-	-	-
5	90 - 110	-	5	3	2	3	4	17	7	18	25	57	32.8	1.53	41	40	40	38	37	36	31	29
6	130 - 165	-	9	12	7	4	1	33	9	19	28	39	34.7	-	-	-	-	-	-	-	-	-

Hor. no.	pH- H2O	KCl	CaCO3 %	ORG- C %	MAT. N %	EXCH Ca	CAT. Mg	K	Na	sum	EXCH H+Al	AC. Al	CEC soil	clay	OrgC	ECEC	BASE SAT %	Al SAT %	EC 2.5 mS cm^{-1}
						cmol$_c$ kg^{-1}													
1	6.1	5.7	-	4.22	0.34	20.1	1.0	0.3	0.0	21.4	0.0	0.0	24.8	54	14.8	21.4	86	0	0.20
2	4.9	4.0	-	1.60	0.17	7.6	0.3	0.1	0.0	8.0	1.4	1.1	16.3	31	5.6	9.4	49	7	0.06
3	5.2	4.1	-	0.80	0.13	8.0	0.0	0.1	0.0	8.1	0.7	0.5	15.8	28	2.8	8.8	51	3	0.03
4	5.5	4.6	-	0.71	0.13	10.1	0.0	0.1	0.0	10.2	0.1	0.0	14.9	27	2.5	10.3	68	0	0.02
5	5.9	5.0	-	0.65	0.11	10.9	0.0	0.1	0.0	11.0	0.0	0.0	15.4	27	2.3	11.0	71	0	0.03
6	7.6	6.8	2.3	0.71	0.12	45.0	0.0	0.1	0.0	45.1	0.0	0.0	20.4	52	2.5	45.1	221	0	0.20

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe & Al (by Na DITHIONITE) / AVAIL. P (Bray)

Hor. no.	MICA /ILL	VERM	CHLO	KAOL	GOET	TALC	Fe	Al	P mg kg^{-1}
1	-	1	6	4	2	1	2.5	0.4	0.7
2	-	1	6	4	2	1	2.7	0.5	0.1
3	-	1	6	4	2	1	3.1	0.5	0.0
4	-	1	6	4	2	1	2.9	0.4	0.1
5	-	1	6	4	2	1	3.0	0.5	0.0
6	4	4	3	6	2	1	3.6	0.5	0.0

Annex 1C ISIS Data Sheet CN 32

ISIS 4.0 data sheet of monolith CN 32 Country : PEOPLE'S REPUBLIC OF CHINA Print date (dd/mm/yy) : 01/06/94

FAO/UNESCO (1988) : Alumi-Ferralic Cambisol (Chromic) (1974 : Orthic Ferralsol)
USDA/SCS SOIL TAXONOMY (1992) : Typic Hapludox, clayey, kaolinitic (allic), thermic (1975 : Tropeptic Haplorthox)
LOCAL CLASSIFICATION : Haplic latored soil

DIAGNOSTIC CRITERIA FAO (1988) : ochric A, cambic B horizon; ferralic properties
USDA/SCS (1992) : ochric epipedon, oxic horizon
Soil moisture regime : udic

LOCATION : Conghua, Wenquan, 2 km on road Jiekou-Fengsheng (Xinfeng)
Latitude : 23°39' 0'' N Longitude : 113°39'30'' E Altitude : 250 m a.s.l.
AUTHOR(S) : Luo/ Van Engelen, V./ Zhang Date (mm/yy) : 11/92

GENERAL LANDFORM : hill Topography : steeply dissected
PHYSIOGRAPHIC UNIT : rounded hills
SLOPE Gradient : 25% Aspect : SW Form : convex
POSITION OF SITE : middle slope
MICRO RELIEF Kind :
SURFACE CHAR. Rock outcrop : nil Stoniness : nil
Cracking : nil Slaking/crusting : nil
Salt : nil Alkali : nil
SLOPE PROCESSES Soil erosion : slight sheet Aggradation : present
Slope stability : stable

PARENT MATERIAL : residual material derived from coarse-acid igneous rock (biotite granite)
Texture : sandy clay
Weathering degree : high Resistance : low

EFFECTIVE SOIL DEPTH : 150 cm

WATER TABLE : no watertable observed
DRAINAGE : well
PERMEABILITY : high; no slowly permeable layer(s)
FLOODING Frequency : nil Run off : medium
MOISTURE CONDITIONS PROFILE : 0 - 50 cm dry 50 - 250 cm moist

LAND USE : (semi-) natural vegetation (bamboo, Masson pine, Chinese fir)
VEGETATION Type : evergreen forest Status : secondary

ADDITIONAL REMARKS :
Landform: rounded hills with a convex slope form. Hardly any accumulation of material on the lower slope. Therefore a sharp knickpoint towards the flat valley floors.
Soil: about 20cm of colluvial material on top of material. A fully developed Ah horizon is present in this material. No clear reason why colluvium is present.

Slide nos. of the ISRIC collection: 13945-13950 (landscape, profile, profile details).

CLIMATE : Köppen: Cw
Station: JIEKOU 23 52 N/113 32 E 68 m a.s.l. 29 km NNE of site Relevance: moderate

		No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
pan evaporation	mm	20	103	86	100	111	148	157	204	188	184	177	148	118	1722
relative humidity	%	24	71	77	82	83	84	85	81	83	79	74	70	70	78
precipitation	mm	24	56	76	132	277	470	415	225	245	144	85	41	37	2201
no. of raindays		24	10	13	17	17	21	21	18	18	13	7	6	7	167
T mean	°C	24	11.4	12.7	16.8	21.1	25.0	26.7	28.1	27.7	26.2	22.3	17.7	13.5	20.8
T max	°C	24	17.0	17.6	21.2	25.3	29.3	31.0	33.0	32.8	31.1	28.1	23.8	19.6	25.9
T min	°C	24	7.6	9.4	13.6	18.0	21.9	23.7	24.7	24.4	22.7	18.3	13.6	9.3	17.3
windspeed(at 2m)	m s^{-1}	24	1.9	1.8	1.5	1.4	1.3	1.2	1.2	1.0	1.2	1.5	1.8	1.8	1.5
bright sunshine	h d^{-1}	24	3.9	2.9	2.3	2.4	3.7	4.2	7.0	6.4	6.3	6.1	6.0	5.0	4.7
bright sunshine	%	24	36	25	20	19	28	31	52	50	52	53	55	48	39

PROFILE DESCRIPTION :
Deep, well drained, dark brown to yellowish red gravelly clay derived forom biotite granite covered by a dark (yellowish) brown colluvial layer of about 20 cm thick. The colluvial layer has a high content in organic carbon and exhibits weakly to moderately developed subangular blocky structures. The subsoil dominantly has moderately to strongly developed medium angular blocky structures. The buried A horizon still has a medium content in organic carbon. The soil reaction is strongly acid throughout.

Ah	0 - 8 cm	Dark yellowish brown (10YR 4/6, moist) to yellowish brown (10YR 5/4, dry) slightly gravelly sandy clay loam; leaves, undecomposed; weak to moderate medium subangular blocky structure; slightly sticky, slightly plastic, friable, very hard; many fine to coarse continuous exped-inped vesicular pores; highly porous; many very fine to coarse roots throughout; frequent worm channels; clear wavy boundary to
AB	8 - 20 cm	Dark brown (7.5YR 4/4, moist) to strong brown (7.5YR 4/6, dry) gravelly sandy clay; moderate medium subangular blocky structure; sticky, plastic, firm, hard; common fine to very fine continuous exped-inped tubular pores; moderately porous; many very fine to coarse roots throughout; frequent worm channels; clear smooth boundary to
2Ah	20 - 36 cm	Dark yellowish brown (10YR 3/4, moist; 10YR 4/4, dry) gravelly sandy clay; moderate medium to coarse subangular blocky structure; sticky, plastic, friable, very hard; many fine to coarse continuous exped-inped tubular pores; highly porous; common very fine to coarse roots throughout; frequent worm channels; clear wavy boundary to
2AB	36 - 55 cm	Strong brown (7.5YR 4/6, moist; 7.5YR 5/6, dry) gravelly clay; moderate medium angular blocky structure; very sticky, very plastic, firm, very hard; patchy thin clay cutans on pedfaces; common fine to very fine continuous exped-inped tubular pores and few medium random continuous exped-inped tubular pores; highly porous; few fine and coarse roots throughout; few channels; gradual smooth boundary to
2Bt1	55 - 75 cm	Yellowish red (5YR 5/6, moist) gravelly clay; moderate to strong medium angular blocky structure; very sticky, very plastic, firm; broken thin clay cutans on pedfaces; common fine to very fine continuous exped-inped tubular pores and few medium random continuous exped-inped tubular pores; moderately porous; few very fine and fine roots throughout; few channels; gradual smooth boundary to
2Bt2	75 - 130 cm	Yellowish red (5YR 5/8, moist) very gravelly clay; moderate to strong angular blocky structure; very sticky, very plastic, firm; continuous moderately thick clay cutans on pedfaces; common fine to very fine continuous exped-inped tubular pores; moderately porous; few very fine roots throughout; clear irregular boundary to
R	130 - 250 cm	Yellow (10YR 7/8, moist) highly weathered biotite granite

ANALYTICAL DATA :

Hor. no.	Top - Bot	>2 mm	2000 1000	1000 500	500 250	250 100	100 50	TOT SAND	50 20	20 2	TOT SILT	<2 µm	DISP	BULK DENS	pF- 0.0	1.0	1.5	2.0	2.3	2.7	3.4	4.2
1	0 - 8	-	12	17	9	6	2	46	1	17	18	36	-	-	-	-	-	-	-	-	-	-
2	8 - 20	-	15	13	7	5	2	42	2	16	18	40	-	-	-	-	-	-	-	-	-	-
3	20 - 36	-	9	11	8	5	2	35	1	17	17	48	-	-	-	-	-	-	-	-	-	-
4	36 - 55	-	13	15	8	5	2	43	2	15	17	40	-	-	-	-	-	-	-	-	-	-
5	55 - 75	-	18	10	5	4	1	38	3	13	15	47	-	1.29	46	43	39	36	35	34	34	29
6	90 - 120	-	14	8	5	4	3	33	3	15	18	49	-	-	-	-	-	-	-	-	-	-
7	140 - 160	-	12	13	10	11	4	51	7	18	25	25	-	-	-	-	-	-	-	-	-	-
8	200 - 220	-	14	20	14	11	7	66	7	17	24	10	-	-	-	-	-	-	-	-	-	-

Hor. no.	pH- H2O	KCl	CaCO3 %	ORG- C %	MAT. N %	EXCH CAT. Ca	Mg	K	Na	sum	EXCH AC. H+Al	Al	CEC soil	clay	OrgC	ECEC	BASE SAT %	Al SAT %	EC 2.5 mS cm^{-1}
						cmol$_c$ kg^{-1}													
1	4.3	3.8	-	2.91	0.23	0.8	0.3	0.3	0.0	1.4	3.5	3.2	10.5	29	10.2	4.9	13	30	0.08
2	4.3	3.9	-	1.36	0.09	0.4	0.0	0.1	0.0	0.5	3.8	3.6	6.9	17	4.8	4.3	7	52	0.04
3	4.3	4.0	-	0.96	0.09	0.2	0.0	0.2	0.0	0.4	3.3	3.2	6.9	14	3.4	3.7	6	46	0.02
4	4.4	3.9	-	0.58	0.07	0.2	0.0	0.2	0.0	0.4	3.6	3.4	6.9	17	2.0	4.0	6	49	0.02
5	4.5	3.9	-	0.48	0.06	0.2	0.0	0.2	0.0	0.4	3.3	3.2	6.9	15	1.7	3.7	6	46	0.02
6	4.6	4.0	-	0.39	0.05	0.2	0.0	0.2	0.0	0.4	3.6	3.4	6.9	14	1.4	4.0	6	49	0.01
7	4.5	4.0	-	0.12	0.02	0.2	0.0	0.1	0.0	0.3	6.8	6.2	8.8	35	0.4	7.1	3	70	0.01
8	4.8	4.0	-	0.04	0.01	0.2	0.0	0.1	0.0	0.3	7.4	5.7	-	-	0.1	7.7	-	-	0.01

CLAY MINERALOGY (1 very weak, ..., 8 very strong) / EXTRACTABLE Fe & Al (by Na DITHIONITE) / AVAIL. P (Bray)

Hor. no.	MICA /ILL	CHLO	SMEC	KAOL	GIBB	GOET	Fe	Al	P mg kg^{-1}
1	2	3	-	8	1	1	1.4	0.2	3.0
2	2	3	-	8	1	1	1.5	0.2	0.0
3	3	3	-	8	1	1	1.4	0.3	0.0
4	3	3	-	8	1	1	1.5	0.3	0.0
5	3	3	-	8	1	1	1.5	0.3	0.0
6	3	3	-	8	1	1	1.6	0.3	0.0
7	3	3	3	6	1	1	1.7	0.3	0.0
8	3	-	4	4	1	1	0.7	0.1	0.0

Annex 2 Units, Glossary, Classes and Acronyms

UNITS

Chinese weights and measures	SI equivalent
1 mu	0.067 ha
1 jin	0.5 kg
1 jin/mu	0.133 kg ha^{-1}

Other units

$cmol_c\ kg^{-1}$	centimol charge per kilogram (formerly meq/100 g; 1 meq/100 g = 1 $cmol_c\ kg^{-1}$)
μm	micro-metre: $1/1000^{th}$ of a millimetre.
$mg\ kg^{-1}$	milligram per kilogram (formerly parts per million (ppm))
$mS\ cm^{-1}$	milliSiemens per cm at 25°C (formerly mmho cm^{-1})
MJ	Megajoules (formerly kcal; 1 MJ = 4186.8 kcal)

GLOSSARY

Air capacity	Amount of pore space filled with air 2 or 3 days after soil has been wetted. It is calculated from the difference between amount of water under almost saturated conditions (pF 0.0) and moisture retained at "field capacity" (pF 2.0), and expressed as volume percentage.
Al saturation	Ratio of exchangeable aluminium to the CEC, expressed as percentage.
Available soil moisture	Amount of moisture retained between "field capacity" (pF 2.0) and "wilting point" (pF 4.2), expressed as volume percentage (also called "available water capacity"). It is indicative of the amount of moisture available for plant growth.
Base saturation	Ratio of the sum of bases to the CEC, expressed as percentage.
Bulk density	Weight of an undisturbed soil sample divided by its volume.
CEC	Cation exchange capacity, indicative of the potential nutrient retention capacity of the soil.
Clay mineralogy	Type of clay-sized (< 2μm) particles.
kaolinite	Clay mineral with a low nutrient retention capacity, common in soils from (sub)tropical regions.
smectite	Silica-rich clay mineral with a high nutrient retention capacity and the ability to absorb water, resulting in swelling of the clay particles.
illite	Potassium-rich clay mineral with a moderately high nutrient retention capacity, common in soils from temperate regions and in alluvial soils.
vermiculite	Clay mineral with a high nutrient retention capacity and strong potassium-fixation.
chlorite	Aluminium-rich clay mineral with a moderately high nutrient retention capacity, occurring in variable quantities in soils rich in aluminium.
halloysite	Clay mineral with a moderately high nutrient retention capacity, common in soils derived from volcanic ashes.
quartz	Residual silica, resistant to weathering.
feldspar	Residual primary mineral, unstable in soil environments and, if present, indicative of a slight to moderate degree of weathering.
hematite	Reddish coloured iron oxide, common in well drained soils of tropical regions.
goethite	Yellowish coloured hydrated iron oxide, common in soils of temperate regions.
gibbsite	Aluminium hydroxide, indicative of a high degree of weathering.
Consistence	Refers to the degree and kind of cohesion and adhesion of the soil material, or to the resistance to deformation or rupture.
ECEC	Effective cation exchange capacity. It is calculated by addition of the sum of bases and exchangeable acidity, and reflects the actual nutrient retention capacity of the soil.
ESP	Exchangeable sodium percentage, ratio of exchangeable sodium to the CEC, expressed as percentage.
Exchangeable acidity	Sum of exchangeable hydrogen and aluminium.
Fine earth fraction	Part of the soil material with a particle-size of 2 mm or less (nearly all analyses are carried out on this soil fraction).
Horizon	Layer of soil or soil material approximately parallel to the earth's surface.
Land characteristic	Measurable property of land (e.g. texture).
Land quality	Set of interacting land characteristics which has a distinct influence on land suitability for a specified use (e.g. erosion hazard, which is a.o. influenced by slope, rainfall intensity, soil cover, infiltration rate, soil surface characteristics, texture).
Leaching	Downward or lateral movement of soil materials in solution or suspension.
Mottle	Spot or blotch differing in colour from its surroundings, usually indicative of poor soil drainage.

Organic carbon	Content of organic carbon as determined in the laboratory (% org. C x 1.72 = % org. matter)
Parent material	The unconsolidated mineral or organic material from which the soil is presumed to have been developed by pedogenetic processes.
pF value	Measure for soil moisture tension.
SAR	Sodium adsorption ratio of the soil solution, indicative of sodication hazard.
Soil reaction (pH)	Expression of the degree of acidity or alkalinity of the soil.
Soil structure	Aggregates of primary soil particles (sand, silt, clay) called peds, described according to grade, size and type.
Sum of bases	Total of exchangeable calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^{+}) and sodium (Na^{+}).
Texture	Refers to the particle-size distribution in a soil mass. The field description gives an estimate of the textural class (e.g. sandy loam, silty clay loam, clay); the analytical data represent the percentages sand, silt and clay measured in the laboratory.
Water soluble salts	Salts more soluble in water than gypsum.

CLASSES OF SOME ANALYTICAL SOIL PROPERTIES

Organic Carbon - C (%)

< 0.3	very low
0.3 - 1.0	low
1.0 - 2.0	medium
2.0 - 5.0	high
> 5.0	very high

Acidity pH-H_2O

< 4.0	extremely acid
4.0 - 5.0	strongly acid
5.0 - 5.5	acid
5.5 - 6.0	slightly acid
6.0 - 7.5	neutral
7.5 - 8.0	slightly alkaline
8.0 - 9.0	alkaline
> 9.0	strongly alkaline

Available phosphorus (mg kg^{-1})	**Olsen**	**Bray**
low	< 5	< 15
medium	5 - 15	15 - 50
high	> 15	> 50

CEC [pH7] ($cmol_c$ kg^{-1} soil)

< 4	very low
04 - 10	low
10 - 20	medium
20 - 40	high
> 40	very high

Sum of bases ($cmol_c$ kg^{-1} soil)

< 1	very low
1 - 4	low
4 - 8	medium
08 - 16	high
> 16	very high

Base saturation - BS [CEC pH7] (%)

< 10	very low
10 - 20	low
20 - 50	medium
50 - 80	high
> 80	very high

Aluminium saturation (%)

< 5	very low
05 - 30	low
30 - 60	moderate
60 - 85	high
> 85	very high

Exchangeable sodium percentage - ESP (%)

Soil structure		*Crops*
< 5	very low	< 2
05 - 10	low	02 - 20
10 - 15	medium	20 - 40
15 - 25	high	40 - 60
> 25	very high	> 60

Bulk density (kg dm^{-3})

< 0.9	very low
0.9 - 1.1	low
1.1 - 1.5	medium
1.5 - 1.7	high
> 1.7	very high

ACRONYMS

FAO	Food and Agriculture Organization of the United Nations
ISIS	ISRIC Soil Information System
ISRIC	International Soil Reference and Information Centre
ISSAS	Institute of Soil Science - Academia Sinica
SCS	Soil Conservation Service
UNESCO	United Nations Educational, Scientific and Cultural Organization
USDA	United States Department of Agriculture

Soil Briefs of China

(ISSN: 1381-6950)

No.	Title	No. of soils*
China 1	Red reference soils of the subtropical Yunnan Province	3
China 2	Reference soil ("Latosol") of tropical southern Yunnan Province	1
China 3	Yellow/brown reference soils of subtropical Guizhou Province	3
China 4	Purple upland and lowland reference soils of subtropical Sichuan Province	2
China 5	Reference soils of the subtropical mountains of Jiangxi Province	3
China 6	Reference soils of the subtropical mountains of Guangdong Province	3
China 7	Reference soils of tropical China (Hainan Island)	4
China 8	Reference soils of the Red Basins of Jiangxi Province	5
China 9	Reference soil of Chaoyang County, typical of the formerly wooded hilly areas in the SW of Liaoning Province	1
China 10	Reference soils of the Liaohe plain, Liaoning Province	2
China 11	Reference soil of the Changbai Mountains, Jilin Province	1
China 12	Reference soils of the Songnen plain, Heilongjiang Province	4
China 13	Reference soil of the Wudalianchi volcanic area, Heilongjiang Province	1
China 14	Reference paddy soils of the eastern alluvial lowlands of China (in prep.)	3

Country Reports

(ISSN: 1381-5571)

No.	Country	No. of soils*	No.	Country	No. of soils*
1	Cuba	22	15	Gabon	6
2	P.R. of China	51	16	Ghana	in prep.
3	Turkey	15	17	Philippines	6
4	Côte d'Ivoire	7	18	Zimbabwe	13
5	Thailand	13	19	Spain	20
6	Colombia	18	20	Italy	17
7	Indonesia	48	21	Greece	in prep.
8	Ecuador	in prep.	22	India	in prep.
9	Brazil	28	23	Kenya	in prep.
10	Peru	21	24	Mali	in prep.
11	Nicaragua	11	25	Nigeria	in prep.
12	Costa Rica	12	26	Mozambique	in prep.
13	Zambia	11	27	Botswana	in prep.
14	Uruguay	10			

* State of reference collections as of January 1995