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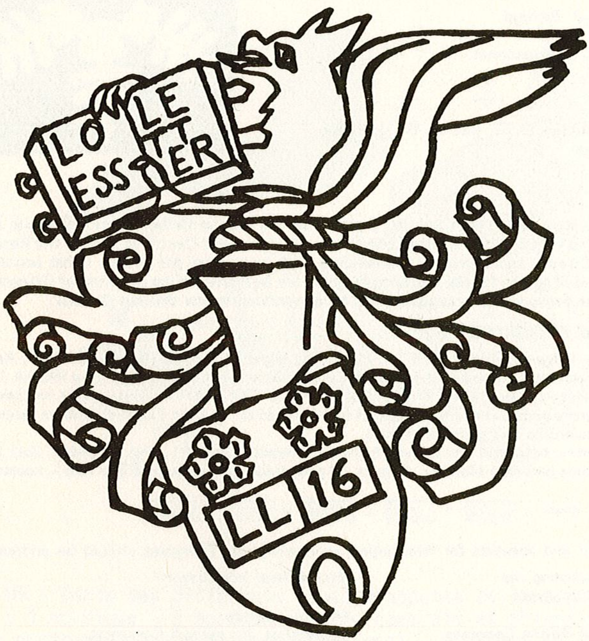
La LETTRE du LOESS

LOESS LETTER 16



LOESS IN NORMANDY, JERSEY & BRITTANY: 20 - 27 AUGUST 1986

LL MOVES TO LEICESTER · FROM MAY 1986

XII INQUA CONGRESS
OTTAWA, CANADA, 1987

By the unanimous decision of the General Assembly of the XI Congress of the International Union for Quaternary Research, held in Moscow, U.S.S.R., the XII International Congress will take place in Ottawa, Canada, from the 31st of July to the 9th August, 1987.

The Congress will be sponsored by the Canadian Quaternary Association, l'Association québécoise pour l'étude du Quaternaire and the National Research Council of Canada. Both the International Union for Quaternary Research (through the International Union of Geological Sciences) and the National Research Council of Canada are adhering members of the International Council of Scientific Unions.

The Canadian National Committee and the Organising Committee take pleasure in inviting you to participate in the Technical and Social Programmes of the XII Congress.

ORGANISING COMMITTEE OF THE XII CONGRESS

President: Dr. N.W. Rutter
Vice-President: Dr. D.A. St-Onge
Secretary-General: Dr. A.V. Morgan

COMMITTEES

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N.R.C. Representative:
K. Charbonneau.

SITE

The XII Congress will be held in the Congress Centre and The Westin Hotel in central Ottawa. Accommodation will be in The Westin Hotel situated adjacent to the Congress Centre as well as the Residences of the University of Ottawa, approximately five minutes walk away from the Centre. Other accommodation has been reserved at nearby hotels. Camping facilities are available on the outskirts of Ottawa. **Costs of accommodation and reservation procedures will be announced in the Second Circular.**

DURATION OF THE CONGRESS

The XII Congress will open on Friday, July 31, 1987, and close on Sunday, August 9, 1987. Activities of the Congress will include sessions of the INQUA General Assembly, meetings of the INQUA Council, Commissions and Subcommissions, and all scientific sessions. The scientific programme will take place throughout the Congress period with the exception of Wednesday, August 5, which will be reserved for local excursions of scientific and general interest.

Pre-Congress scientific field trips will be held between Tuesday, July 21, and Thursday, July 30; and post-Congress field trips between Monday, August 10 and Wednesday, August 19, 1987, unless otherwise designated.

SECRETARIAT

All correspondence and requests for information concerning the Congress should be addressed to:

(For information concerning the organization of the Congress)
Dr. Alan V. Morgan,
Secretary-General XII INQUA Congress,
Department of Earth Sciences,
University of Waterloo,
WATERLOO, Ontario.
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(For general information)
Mrs. L. Baignée
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LL

INQUA 87

LL16 October 1986

Loess Letter is published by the Quaternary Research and Geological Engineering Groups of the University of Waterloo; it is the newsletter of the INQUA Loess Commission. LL appears twice a year, normally in April and October (publication dates actually vary somewhat to coincide with major loess related events). Brief research papers are published, also reviews and digests of recently published material, and news items and announcements. Inquiries about the work of the INQUA Loess Commission can be addressed to the President: Professor Marton Pecsi, Geographical Research Institute, Hungarian Academy of Sciences, H 1112 Budapest, Budaorsi ut. 43-45, Hungary. LL16 is the last of the Waterloo sequence of LLs; from LL17 production will be based at the University of Leicester (see below).

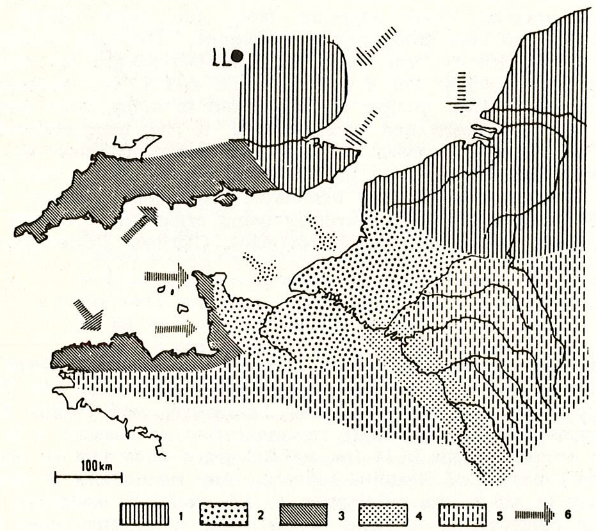

Figure 85 - Carte des différents types d'apports éoliens pendant le Weichsélien : 1 nordique - 2 normand (Manche centrale et orientale) - 3 breton (Manche occidentale) - 4 Seine - 5 régional - 6 direction des vents nourrissiers.

LL16 is a special issue to mark the Normandy-Jersey-Brittany field trip and conference in August 1986. We feature extracts (mainly pictorial) from 'Le cycle periglacaire Pleistocene en Europe du Nord-Ouest' by J-P Lautridou, to provide some background information on this important loess region. Note in particular Lautridou's observations on the definition of 'loess'. We also feature some discussion on the problems of definition - these will be considered at the Normandy meeting. We still have some way to go before we achieve a definition which is acceptable to all investigators and scholars.

LL16 is a transition issue - as it is circulated LL will be moving from Waterloo to Leicester. To gain a world wide view and to avoid becoming too committed to the interests of one region LL moves regularly from continent to continent. The first seven issues were produced in Australasia, the next nine were based in North America; from LL17 the editorial office is in Europe. Send contributions and requests to Professor Ian Smalley, Geography Department, Leicester University, Leicester LE1 7RH, England. LL17 will be dated April 1987 and should be the first of two special issues for the August 1987 INQUA Congress in Ottawa, Canada.

A major feature of LL16 is a selection of material from the 1985 Xian Loess Conference. We offer some of the entries from the comprehensive abstacts volume, chosen to reflect the level of international participation; and we also reprint some extracts from the book 'Loess and the Environment', by Liu Tung-sheng and his collegues. The Xian Conference was reported on in Nature by Ann Wintle and Ed Derbyshire; we reprint their report. The Xian meeting was a great success and a fine demonstration of the healthy state of loess studies in China, and in many other parts of the world, and the organisers and sponsors are to be congratulated. Loess Commission members and others interested in loess should now be organising to attend the loess discussions at the INQUA Congress to be held in Ottawa, Canada in August 1987. The associated field-trip through the loess heartlands of North America is currently being organized - details from Dr. Alan Lutenegger, Civil Engineering Department, Clarkson University, Potsdam, NY 13676, U.S.A.

Editorial and production. The current LL editorial board is: Ian Smalley, Marton Pecsi, J.-P. Lautridou, Karl Brunnacker, Liu Tung-sheng, Edward Derbyshire, A.E. Dodonov, Alan Lutenegger and Dennis Eden. The board is supposed to be as widely representative as possible - in terms of country and subject. With LL16 the NSERC grant ends and we may need to find some new sources of financial support. Any suggestions or proposals for raising money to aid in the publication of LL would be welcome. Also any comments or observations on ways to make our newsletter more interesting and useful would be well received. LL is attempting to provide a link between loess investigators in many countries, who work in many languages and in many disciplines - it may be that some aspect of loess is being inadvertently overlooked - please write and let us know.

LL16, the last of the Waterloo LLs, was produced by Ian Smalley, Agnes Kolic and Nadia Bahar in the Department of Earth Sciences, and printed by the Graphic Services Section of the University of Waterloo. Funding from the Natural Sciences and Engineering Research Council of Canada for LLs 8-16 is gratefully acknowledged. Thanks to Tin Drum Information Services and the Polyfocus/Polystyle design group for their usual help. Send material for LLs 17 and 18 to Leicester - these will be special issues for INQUA '87 - see p 2. Contributions for the conference loess volume should be sent to Professor Marton Pecsi (at address on p. 3).

LOESS AND THE ENVIRONMENT

Liu Tungsheng et al.

China Ocean Press Beijing
1985

FOREWORD

The book on "Loess and the Environment" is now in your hands. Since the 1980 personnel of the Quaternary Research Laboratory of the Institute of Geology, the Quaternary Geochemical Research Laboratory of the Institute of Geochemistry, and Xian Laboratory of Loess and the Quaternary Geology of Academia Sinica have been investigating loess at Luochuan, Shaanxi Province, in continuation of the past work. This book is the result of a great deal of cooperation.

By now, twenty years have elapsed since the book on "The Composition and Texture of Loess" was written jointly by the personnel mentioned above in 1964, with Luochuan loess as the major object of the study. It has been over thirty years since the study of loess was begun and the first Laboratory of the Quaternary Research in China was established at the Institute of Geology, At that time, none of us thought that we could continue studying loess and jointly publish monographs after twenty, even thirty years. We are very glad to be capable of studying loess as our life work, and to continue in our collective long-term cooperation, which enabled our recent progress. We now understand what the twenty years and thirty years of continuing research mean. The hardship and significance of scientific research resides in continuity of this sort.

Time has deepened our understanding of loess, time enabled us to learn from the past work, and time also forces us to look further ahead. The content of this book is a review of our loess research and of our future plans.

When the Sanmenxia Reservoir Project was begun in 1953, we carried out loess research and made a comprehensive investigation of water and soil conservation along the middle reaches of the Huanghe (Yellow) River under the guidance of the late Prof. Zhu Kezhen (Kuochin Chu), the former vice president of Academia Sinica. After this investigation in 1958, we made a reconnaissance along ten major geological profiles on the Loess Plateau. From 1958 to 1961, we had surveyed loess outside the Plateau in Shandong, Qinghai and Hebei Provinces, and compiled "The Map of Loess Distribution in China". At that time, many young men worked on the Plateau night and day. During 1962–1964, two monographs, "The Loess Along the Middle Reaches of the Huanghe (Yellow) River" and "The Loess Deposits of China" were completed with the support offered by the late Prof. Hou Defeng, the Director of the Institute of Geology, and Yu Xiangchun and Peng Hui. Afterwards, we made an investigation of Luochuan loess for the first time and then published the book "The Composition and Texture of Loess".

Over twenty years have elapsed. Along with the progress of scientific study, some of other coworkers became involved in started new research fields. On the occasion of the publication of this book, we first think of them. This book contains their work and thoughts. Their wisdom, and their style are manifested in this book through the lasting imprint they made on the thinking of the authors.

Besides us, many people in many institutions have been engaged in loess research in China over the past two decades, especially the personnel working in agricultural and engineering departments. Their understanding and comprehension of loess has inspired our ideas and raised our attention. Their work has helped us to study more rigorously and act with more caution, in this manner avoiding possible mistakes. This mutual encouragement is difficult to express merely by thanks.

The results obtained from 1954 to 1966 are as follows:

1. Before participating in the VIth International Quaternary Congress held in Poland in 1961, under the guidance of the late Prof. Li Siguang (J. S. Lee), the former vice-presidnet of Academia Sinica, we had divided the loess series of China into Malan Loess (continued use of the old name), Lishi Loess and Wucheng Loess. Combined loess stratigraphic and biostratigraphic subdivision and nomination have been gradually adopted by geological circles in the country. The definition of loess deposits in China, consequently, has been expanded and includes sediments region from the former less than 20 m thick to over 200 m thick. The geological age of loess in China from Late Pleistocene to the whole Quaternary. From the point of view of engineering geology, Malan Loess belongs to collapsible loess, while Lishi Loess and Wucheng Loess are basically non-collapsible. This is of significance for construction in the Loess Plateau. Meanwhile, the recognition of older loess in China is of worldwide paleoclimatic significance. In recent years, scholars in Europe and America began to pay increased attention to old loess strata.

2. As far as particle composition and microtexture of loess is concerned Wang Tingmei, Su Lianyi and Zhu Haizhi classify loess into three belts: sandy loess, loess and clayey loess, progressing from northwest to southeast. The belts reflect the dynamic action of wind transportation of loess, and demonstrate that sandy loess is the main source of silt along the lower reaches of the Huanghe River. And this is of great importance in controlling the silt in the Huanghe River.

3. Through continuous work on loess and paleosol sequence, Wang Kelu, Wu Zirong, Wen Qizhong, Yang Lihua, Guo Xudong (Guo Jinluan), Lu Yanchou and An Zhisheng recognised at Luochuan, the first, the second and the third sandy loess layer (also called the upper, the lower and the bottom sandy loess layer). Coarse grained sandy loess is a good aquifer in the loess "Yuan" area. It represents dry and cold climate in terms of depositional environment.

All the above results have already been described in the three books mentioned earlier. In this book the authors discuss several problems raised by the work done from 1966 to 1984, especially between 1980 and 1984.

1. Considering chronostratigraphy, the time-scale of deposition of loess and paleosol sequence has been obtained by using paleomagnetic, thremoluminescence and radiocarbon dating techniques. From top downward, the dated layers are: Modern loess (contemporary windborne dust deposits), and loess of the past 10,000 years (Holocene loess, dated by ^{14}C); loess of the past 100,000 years (Malan Loess, dated by thermoluminescence); paleosol about 500,000 years old (5th paleosol, corresponding to the time of the 10th layer with *Homo erectus pekinensis* at Zhoukoudian); the first sandy loess about 800,000 years old (deposited before the B/M boundary); the second sandy loess about 1,150,000 years old (deposited before Jaramillo subchron); paleosol assemblage about 1,800,000 years old (in the middle part of Wucheng Loess, in Olduvai subchron); basal loess deposited about 2,400,000 years ago (after M/G boundary).

The chronologic framework makes it possible to study accurately the sequence of geologic events from the time when loess began to accumulate, to the time it reached a 200 m thickness. It shows us the climate of Loess Plateau changed, how ancient humans and other fauna (especially rodents in loess region) and vegetation evolved and how gullies and ravines formed in the past 2.4 million years. Thus one can trace back the character and range of environmental changes, and find out their duration. In this sense, the Loess Plateau in China may present unique opportunities for the study of Quaternary environmental change.

2. Environmental assessment of the Loess Plateau. The control of Plateau environmental is a task of top priority. What is the process of soil erosion? How did gullies and ravines form? Did the arid environment of the present steppe evolve from the former forest vegetation? What was the history of the Loess Plateau, and what will be its future? Appraising the Loess Plateau requires considering it as a system which includes subsystems from inorganic (soil composition) to organic (organism and its activities), scales from macroscopic (geomorphy, structure of strata, etc.) to microscopic (common and trace elements, heavy minerals, clay minerals and distribution of amino acids), times from past to present, zones from source through transportation area to accumulation and redeposition belts (from western China to eastern China), and so on.

Loess and paleosol sequence in China contains rich geologic information which can be studied as a natural system. Information on the geological aspects of the loess deposits is treated in the first part of this book, with further comprehensive analysis to be made in future work.

3. The process of loess formation can be deduced by analysing the processes of the transportation and deposition of modern silt in dust storms. Such studies may provide basis for models of lifting, transportation and deposition of loessial deposits. After the study of drifting sand by Bagnold (1941) attention was focused on sand and sand dunes, less on eolian silt. One of the reasons is that it is difficult to find dust deposition areas in nature, whereas in the oceans, lakes, rivers, or in sand dunes study of depositional processes is relatively simple. However, the vast area from Xinjiang in the west to the North China Plain in the east is unique and the complete process of transportation and deposition of silt, i. e. building material of loess can here be studied. In addition, there are historical records spanning several thousand years, and more weather and climate observations of the dust storms (recent equivalent of loess formation) are added each year.

The study of all the processes leading to loess deposition will probably answer many unsolved problems related to loess, for example, the source of kaolinite in loess, the reason of the high $CaCO_3$ content in loess, and the formation mechanism of silt size, sharp angular quartz particles. All these problems are of major importance in protection of current environment in particular the knowledge of mechanism of wind transport of dust and correct comprehension of the propagation of solid particles in the atmosphere.

4. Loess-paleosol sequence records the evolutionary history of geological events leading to the formation of loess deposits and the development of paleosols during the past 2.4 million years. In loess-paleosol sequence geologic and climatic events are inseparable. The well-developed polygenetic paleosol of the 5th and the 2nd paleosol assemblage (W_{s-2}) record the episodes of optimal climate; Malan Loess and 1st and 2nd sandy loess layers record significant dry-cold climatic events. Such extremes happening in the long process of geological history should be regarded as abrupt occurrences of global significance. Loess and paleosols are treated in this book as geologic units sensitive to climate. According to the probable climatic signature of loess and paleosols, the history of long-term climatic fluctuations in the Loess Plateau has been semi-quantitatively reconstructed, and correlated with the oxygen isotope record of the deep-sea sediments. The information on global climatic fluctuations provided by loess-paleosol sequence over the past 2.4 million years is more detailed, in a sense, than that in deep-sea sediment. By the multispectral analysis of loess-paleosol sequence over the past one million years, the periods of different oscillations have been obtained, enabling the prediction of future geological and climatic events in the Loess Plateau and of the trend of future environmental changes. The analysis of short term periodicities is the major remaining task in the research of environmental trends at the Loess Plateau.

To sum up, various environmental processes and the depositional process of loess, closely related to climatic fluctuations are reflected by loess-paleosol sequence of the 2.4 million years, and constitute a perfect three-dimensional system. This is a new orientation for further study of loess.

Naturaly different views of individual problems are expressed in parts of this book. It is considered better to present all the different views to the reader and let him draw his own conclusion rather than to nip off young shoots of possible breakthrough only for the sake of coherence of materials presented in this book. Some results described in this book are tentative leaving much work to be done. In this respect readers are requested to make their comments and present their criticism to the authors.

The book presents collective results which were jointly discussed but separately written. Chapter 1 was written by Lu Yanchou, section I of Chapter 2 by Zheng Honghan, section II by Wu Zirong and Yuan Baoyin, section I of Chapter 3 by Liu Tungsheng, Wen Qizhong, An Zhisheng and Han Jiamao, section II by An Zhisheng and Liu Tungsheng, section III by Qiao Yulou, Huang Baolin, Shen Chengde and Zhou Mingfu, section IV by Zheng Honghan, section V by An Zhisheng and Liu Tungsheng, section I of Chapter 4 by Zheng Shaohua, Yuan Baoyin, Gao Fuqing and Sun Fuqing, section II by Chen Deniu, Gao Jiaxiang, Gao Fuqing and Liu Tungsheng, section III by Zhou Kunshu, Lin Shaomeng, Liu Ruiling and Zhu Yizhi, section I of Chapter 5 by Hu Biru and Lu Yanchou, section II by Wei Lanying, section III by Han Jiamao, Zheng Honghan and Gu Xiongfei, section IV by Wen Qizhong, Diao Guiyi and Sun Fuqing, section V by Wen Qizhong and Yu Suhua, section VI by Xiang Mingju, Sun Fuqing and Wen Qizhong, section VII by An Zhisheng and Lu Yanchou, section I of Chapter 6 by Chen Mingyang and Liu Tungsheng, section II by An Zhisheng, Geng Ansong and Zheng Honghan, section III by Liu Tungsheng, An Zhisheng, Wen Qizhong, Zheng Honghan and Lu Yanchou, section IV by Lu Longhua and An Zhisheng, section V by Wen Qizhong, Diao Guiyi and Yu Suhua, section VI by Yu Zhicheng and Gao Fuqing, section VII by Wei Lanying and Lu Yanchou, section VIII by Chen Mingyang, section I of Chapter 7 by Zhang Shouxin, section II by Li Huhou.

Our cordial thanks goes to the several institutions that have made contributions to the study of loess and given us support and help. They are Northwest University, Institute of Hydrogeology and Engineering Geology of the Chinese Academy of Geological Sciences, Hydrogeological Teams No. 1 and 2 of Bureau of Geology and Mineral Resources of Shaanxi Province, Huanghe River Water Conservancy Committee of the Ministry of Water Conservancy and Electric Power, Research Academy of Meteorology of the National Bureau of Meteorology, Ministry of Foundation Base of the Academy of Architecture, Institute of Water and Soil Conservation, and Nanjing Institute of Pedology, Academia Sinica. We are indebted, for their concern and assistance in the preparation of this book, to leading members of the Division of Earth Sciences, Xian Branch of Academia Sinica. Participating in the Study of clay minerals of loess, the late Gu Xiongfei had also prepared the manuscripts and collected the material, and in his passing we lost a very responsible editor. Wu Zelin did much editing. An Zhisheng and Han Jiamao did a lot in organizing collective effort which led to the writing of this book. Shao Xingya, Yu Zhicheng, Shen Xiaodong, Chen Aihua, Wang Zhiyu, Gong Shuhua and Zhang Ying prepared the illustrations. Gui Wenli, Zhang Yaguang, Xu Yun and Cheng Yingliang prepared the photographs. Gao Fuqing, Zhu Yizhi and Zhou Yongzhang did much work in arranging the materials and checking the data. Han Jiamao, Cui Jiuxu and Bater were responsible for the arrangement of references. Li Huamei, Wang Junda, Lu Liangcai, Huang Renliang, Wang Mingliang and Li Haibin helped us in loess research work. Zhu Xianmo, Wang Yongyan, Zhang Zonghu, Xi Chengfan, Dai Yingsheng, Ding Guiyu, Zhu Haizhi, Wang Kelu, Zhang De'er, Qiu Shihua, Ma Xinghua, Liu Chun, Liu Chengzuo, Zhu Bingquan, Zhu Fukang. Wang Deqian and Chen Yun gave us support and reviewed sections of this book. We hereby express our thanks to all of them.

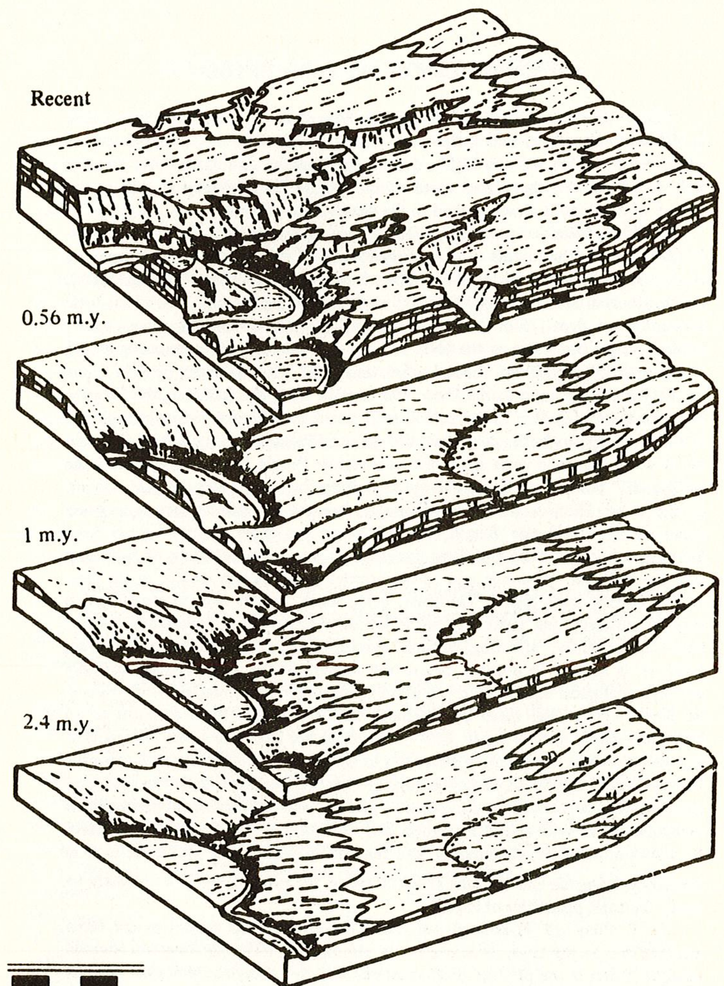

Fig. 2.6 Developing process of valleys in loess "Yuan" region of Luochuan.

CHAPTER 1
A BRIEF HISTORY OF LOESS STUDIES IN CHINA

THE SIGNIFICANCE OF THE STUDY OF LOESS

Loess* covers about 10% of the land surface of the Earth and is concentrated in the temperate zones and in semi-arid desert margins: in the so called "world wheat belt", which are the highly developed industrial and agricultural areas as well as the densely populated areas of the world. The economy as well as the history of mankind is closely linked to the distribution of loess.

In China, loess occupies 440,000 km^2 out of which thick loess amounts to 273,000 km^2 in the middle reaches of the Huanghe (Yellow) River (Liu Tungsheng et al., 1965). Together with the secondary loess (including the North China Plain), the distribution area exceeds 1,000,000 km^2, accounting for over 1/10 of the total area and more than 1/5 of the tillable land of China. Now, more than two hundred million people are living in the loess and secondary loess belts, amounting to 1/5 of the national population. Since ancient times, the cultural development of China has been closely related to the loess. The Lantian Man, the Dali Man, the Dingcun Man and the Hetao Man in the Paleolithic created magnificent prehistoric cultures in the loess region. In the Neolithic, the splended Painted Pottary culture florished six or seven thousand years ago in the loess region. People, at that time, created the earliest dry farming of the world by exploiting the unique natural environment of the Loess Plateau, which, consequently, became one of the first agricultural zones of the world (He Bing-ti, 1969). During the three thousand years from Shang and Zhou to Tang and Song dynasties. It was not a fortuitous phenomenon that the political, economic and cultural center of China was located in the loess and secondary loess region. The loess, being loose, porous and homogeneous, is easy to cultivate, and turns into fertile farmland favorable to agricultural production, consequently, affecting cultural development of ancient societies. Loess, however, is subject to erosion. Severe soil erosion in the Loess Plateau not only destroys ecological equilibrium, but also endangers the lower reaches of the Huanghe River. The annual mean silt discharge of the Huanghe River amounts to 16 hundred million tons or more, 80% of which comes from the Loess Plateau. The dey to harnessing the Huanghe River lies in the water and soil conservation on the Plateau. This involves an understanding of the distribution of loess, its geological age, topographic condition, composition and physico-mechanical properties of its components, as well as the formation and evolution of the Loess Plateau itself. In addition, to solve econmically and reasonably engineering problems, such as saturation slumping and collapse encountered in the loess region, it is necessary to study the basic properties of loess.

R. F. Flint (1974) pointed out that a major theoretical subject in the earth sciences will be the study of evolution of atmosphere, including longterm climatic changes. Loess is the product of atmospheric activity. Abundant biological remains and well developed loess-paleosol sequences are preserved in the Loess Plateau, recording major geological events that had occurred in Eurasia, since the past two million years. Bioclimatic changes, the evolution of ancient man, etc. are all recorded. Recent studies (Liu Tungsheng & Yuan Baoyin, 1982) have shown that the record of biostratigraphic change preserved in the Luochuan loess profile is comparable to that preserved in the profile of Quaternary deep-sea sediments. The Correlation between them will provide clues for resolving mechanism and dynamic forcing of regional and global long-term climatic changes.

In recent years, many scholars considered that the major subject of earth sciences in the 1990's will be the study of interaction between the geosphere and biosphere, of the processes of global evolution, and understanding of the trends of natural environment in which mankind lives. Since loess lies in the belt in which much of the interaction between geosphere and biosphere is taking place, further study of loess will provide valuable material for solving the above-mentioned tasks.

THE TERMINOLOGY AND CONCEPT OF LOESS

"Huangtu" (yellow earth) is a general term for lose earthy deposits used by the Chinese people; its range is different from that of "loess" as used in geology. The deposit referred to as "Huangtu" by the Chinese people is an earth, yellow in color, neither sand, nor mud. Hence "Huangtu" should be an accumulation of silt or dust, yellow in color.

The term "Huangtu" was seen in Chinese literature as early as some two thousand years ago. For example, " in the morning of one day in the fourth month of the third year of Yuanfeng, Jianshi, in the sovereignty of the Emperor Cheng Di, Han Dynasty (78 B. C.), strong winds blew from the northwest. Red and yellow thin, floating clouds were hanging over the sky and yellow dust (Huangtu) fell on the ground from morning till night". (Ban Gu: "The Books of the Western Han Dynasty", Wuxingzhi, Vol. VII). This account by Ban Gu (A. D. 32–92), a great historian, reflects that the ancient Chinese people had an understanding of the relationship between "Huangtu" and wind-borne dust and of the principal properties of "Huangtu". Ban Gu related the term "dust" to loess, vividly describing the particle size of loess.

The German, English, Russian and French equivalents of the Chinese "Huangtu" are Löss, Loess, Лёсс and Leuss, respectively, which are all derived from German Loβ or Loeβ. K. Leonard used the word "Loeβ" based on the word "Loesch" for loose soil as called by the local people of the Rhine Valley. The words "Loesch" or "Losch" and "Los", "Losen" are similar in meaning, and all imply loose and/or loose texture. According to the original meanings of Loss, Loess, Лёсс and Leuss, their relation to loess are not so precise as of the Chinese word "Huangtu".

F. v. Richthofen (1877) carried out geological investigations in China from 1866 to 1872, made a comparison between "Huangtu" in China and Loss of the Rhine Valley in Germany, and held that loesses in China and Germany are basically the same, all being light, greyish yellow calcareous loam, loose, porous, thick layered, nonstratified, with vertical joints, precipice-forming, and often containing terrigenous mollusks, F. v. Richthofen gave the definition of loess with above-mentioned characteristics and considered that loess is generally believed to be eolian in origin, thus, distinguishing them from lacustrine loess-like deposits. Later, V. A. Obruchev (1933, 1958) discussed the problems as "What is loess?", etc. Other scholars such as L. S. Berg (1928, 1946), R. J. Russell (1944), R. F. Flint (1947), Ma Rongzhi (Ma Yung-Chi, 1945), S. S. Morozov (1951), J. Dylik (1954, 1961), V. V. Popov (1957), Zhang Zonghu et al. (1959), N. I. Kriger (1965), I. J. Smalley (1971) have discussed the subject from various points of view. Liu Tungsheng (1958, 1959), Liu Tungsheng and Chang Tsunghu (1962), Liu Tungsheng et al. (1964, 1965, 1966) have made a systematic reivew of the problem.

According to the results of the study of loess and loess-like deposits in various parts of China and referring to the idea of Obruchev (1933), Liu Tungsheng et al. pointed out in 1965 that loess is believed to be wind-derived, not secondarily disturbed, unstratified, calcareous and porous yellow silty earthy deposit. The Loess Plateau in Shanxi, Shaanxi and Gansu provinces is taken as its representative. They further pointed out that basides eolian deposits, yellow, stratified earth silts of other origin with sand and gravel interlayers is called loess-like deposits, and is now called secondary loess. Most of the latter are loess reworked by water and redeposited in arid and semi-arid zones. Their lithologic characters and physico-mechanical properties are similar to those of loess.

DEFINITIONS 1

OXFORD ENGLISH DICTIONARY →

Loess (lö·es, Ger. lös). *Geol.* Also löss, *erron.* loëss. [a. Ger. dial. *lösz.*] A deposit of fine yellowish-grey loam found in the valley of the Rhine and of other large rivers.

1833 LYELL *Princ. Geol.* III. 151 There is a remarkable alluvium filled with land-shells of recent species..which we may refer to the newer Pliocene era. This deposit is provincially termed 'Loess'. 1873 J. GEIKIE *Gt. Ice Age* xxxii. 453 Underneath the vast deposits of löss belonging to the last cold period. 1879 LUBBOCK *Sci. Lect.* v. 141 The antiquities .. are usually found in beds of gravel and loam, or, as it is technically called, 'loëss'.

attrib. 1882 R. K. DOUGLAS *China* vi. 135 The huge tract of loess country in northern China.

OED SUPPLEMENT →

loess. Delete 'found in the valley of the Rhine and of other large rivers' and substitute: which occurs extensively from north-central Europe to eastern China, in the American mid-west, and elsewhere, esp. in the basins of large rivers, and which is usually considered to be composed of material transported by the wind during and after the Glacial Period. (Add further examples.)

1882 F. RICHTOFEN in *Geol. Mag.* IX. 302. I believe I am correct in stating that, among those who have had extensive experience in Loess regions, all who have pronounced an opinion of late years are agreed that subaerial deposition is the only mode of origin by which all its peculiar features can be easily explained. 1906 *Westm. Gaz.* 4 Dec. 2/1 North of the river [*sc.* the Hwang Ho] we come into the land of the loess, a loose light soil of prodigious fertility and the joy of the agriculturist. 1938 C. L. WHITTLES tr. *Reifenberg's Soils Palestine* ii. 25 Microscopic examination shows that loess consists mainly of extremely small particles of quartz together with calcareous particles which frequently, from their markings, etc., have been derived from fossils. 1972 J. G. CRUICKSHANK *Soil Geogr.* ii. 59 During the deglaciation phases of the Pleistocene glaciations, wind-blown silt was deposited on a spectacular scale in extensive, stoneless loess.

loessial (lö·siăl), *a.* [f. LOESS + -IAL.] Composed of loess.

1928 *Bull. Amer. Soil Survey Assoc.* IX. 34 These [*sc.* glacial soils] include the till, moraine, drumlin..and other typical forms and a portion of the loessial deposits. 1974 *Nature* 22 Mar. 320/2 Silt, in excess of that which could be derived from weathering of the substrata and generally considered loessial, is found in many British soils.

loessic (lö·sik), *a.* [f. LOESS + -IC.] = *LOESSIAL *a.*

1909 in *Cent. Dict.* Suppl. 1940 *Nature* 6 July 14/1 In periglacial regions such arid episodes are represented by loessic deposits. 1952 F. E. ZEUNER *Dating Past* (ed. 3) vi. 158 The Middle Older Loess of the section is a complex of loessic hillwash material derived from higher up the slope, and of brecciated loess with large molluscan shells, interrupted by a brown soil.

LL

Karl Caesar v. Leonhard um 1823

DEFINITIONS 2

GREAT SOVIET ENCYCLOPEDIA

LOESS, unstratified, homogeneous, calcareous sedimentary deposit, light yellow or buff in color. Particles 0.01–0.05 mm in size predominate; clay particles smaller than 0.005 mm are present in an amount of 5–30 percent. A certain quantity of particles 0.01–0.05 mm in size is represented by aggregates formed during the coagulation of the colloidal part of the sediment. The porosity of loess is 40–55 percent; it is traversed by narrow tubes (macro-pores, traces of plant remains).

In terms of its composition loess is usually classified as a loam or, more rarely, as a sandy loam. The large particles in the loess consist mostly of quartz and feldspar, and to a lesser degree of mica, hornblende, and so forth. In some interlayers there are many grains of volcanic ash that has been carried by the wind for hundreds of kilometers from the site of eruption. The fine particles in the loess consist of various clay minerals (hydromica, kaolinite, and montmorillonite). Sometimes calcareous concretions (loess dolls, lime nodules), the shells of terrestrial mollusks, and the bones of mammals, particularly rodents and mammoths, are encountered in the loess.

KCvL – the first to use 'löss' as a scientific term ?

Loess is found in Europe, Asia, North America, and South America, predominantly in the steppe and semisteppe regions of the temperate zone. It occurs in the form of a blanket from several meters to 50–100 m thick on water divides, slopes, and ancient valley terraces.

The question of the origin of loess has still not been finally settled. Its formation has been associated with different geological processes (on land with the activity of wind, rainwater and snow meltwater, soil formation and weathering, volcanism, the settling of cosmic dust, and sedimentation in lakes and seas) as well as stages of rock formation. In 1877 the German scientist F. Richthofen proved the subaerial origin of Chinese loess (it was formed on land, and water played a limited role). Also popular are theories of the eolian (V. A. Obruchev), pedogenic (L. S. Berg), and polygenetic (eolian, deluvial, and pedogenic-eluvial processes occurring in an arid climate) origin of loess. The loess has intercalations with a clearly expressed soil profile, that is, buried soils that testify to the existence of warmer and wetter periods (interglacials) than the time during which the loess formed (ice ages).

Loess is the parent rock of chernozem and sierozem soil. It is used for making brick (adobe) and cement and as a filler for levees and dams. After wetting, the loess is often compacted under the pressure of its own weight or the weight of structures, and the ground subsides, which can cause severe damage to structures.

Karl Caesar v. Leonhard um 1823

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N. I. KRIGER [14-1120-1]

J.-P. Lautridou

LE CYCLE PERIGLACIAIRE PLEISTOCENE EN EUROPE DU NORD-OUEST

ET PLUS PARTICULIEREMENT EN NORMANDIE

Nous pouvons en résumé affirmer qu'il existe en Europe du Nord-Ouest un gros stock loessique, homogéne, en dépit de nuances régionales. Nous allons donner dans les paragraphes suivants des exemples précis pour les zones principales et secondaires, en particulier la Haute Normandie et le Bocage normand, mais dès maintenant nous sommes en mesure de le caractériser ainsi :

- *une courbe granulométrique cumulative à fraction 10-50 micromètres dominante, en sigmoïde dissymétrique, à fort pourcentage d'argile fine par rapport à l'argile totale*

- *absence fréquente de carbonate de calcium*

- *stock quartzeux nettement dominant, avec un peu de feldspath, de muscovite (en quantité très variable), un peu de biotite altérée, très peu de glauconie, accessoirement des grains détritiques d'oxyde de fer*

- *des minéraux lourds dominés par l'association épidote amphibole - grenat (quand la fraction sable devient notable) : EDEN (1980) - FAGES (1972) - LAUTRIDOU, (1968) - LAUTRIDOU et al., 1976 - MONNIER, 1980 - JUVIGNE, 1978.*

- *des minéraux argileux où la smectite, la vermiculite, l'illite prédominent, excepté dans le Massif Armoricain (kaolinite dominante, chlorite). Des nuances régionales peuvent être distinguées au niveau de la France du Nord-Ouest (LAUTRIDOU, 1968, JAMAGNE, 1973, JAMAGNE, LAUTRIDOU et SOMME, 1980) et en Belgique (THOREZ et al., 1973).*

Avant d'entamer l'examen détaillé de séquences loessiques, il s'agit de bien s'entendre sur la définition du terme "loess". Certes nous ne ferons pas l'historique des discussions sur la définition du terme, elles-mêmes en rapport avec les hypothèses sur la genèse de ce sédiment (apport allochtone, autochtone, processus de loessification de BERG, 1964 ...). Un chercheur anglais, I.J.SMALLEY, s'est récemment intéressé à nouveau à ce problème (voir en particulier SMALLEY, 1971) ; il rappelle

que la question du mode de transport n'est pas la seule que l'on peut se poser. Quatre problèmes doivent être examinés (SMALLEY, 1975, p. 2-9) : la formation des particules silteuses, l'origine des argiles et du carbonate, le mode de transport et de dépôt des particules, les évènements significatifs postérieurs au dépôt du limon. A la troisième question la réponse (origine essentiellement éolienne) est maintenant généralement admise. Quant à la quatrième question qui pose le problème de la loessification (redistribution du carbonate, ou décalcification et remaniement du matériel) et de l'influence des pédogenèses tardiglaciaires et holocènes nous verrons à propos des limons à doublets qu'en ce domaine il reste des progrès à faire. Pour répondre à ce souci nous avions proposé en 1967 une définition génétique du type morpho-climatique :

"Loess : formation limoneuse, d'origine éolienne, qui s'inscrit en France dans un cycle morphogénétique de climat froid et aride, et dont les modalités varient en fonction des conditions climatiques régionales" (LAUTRIDOU, 1969, p. 127).

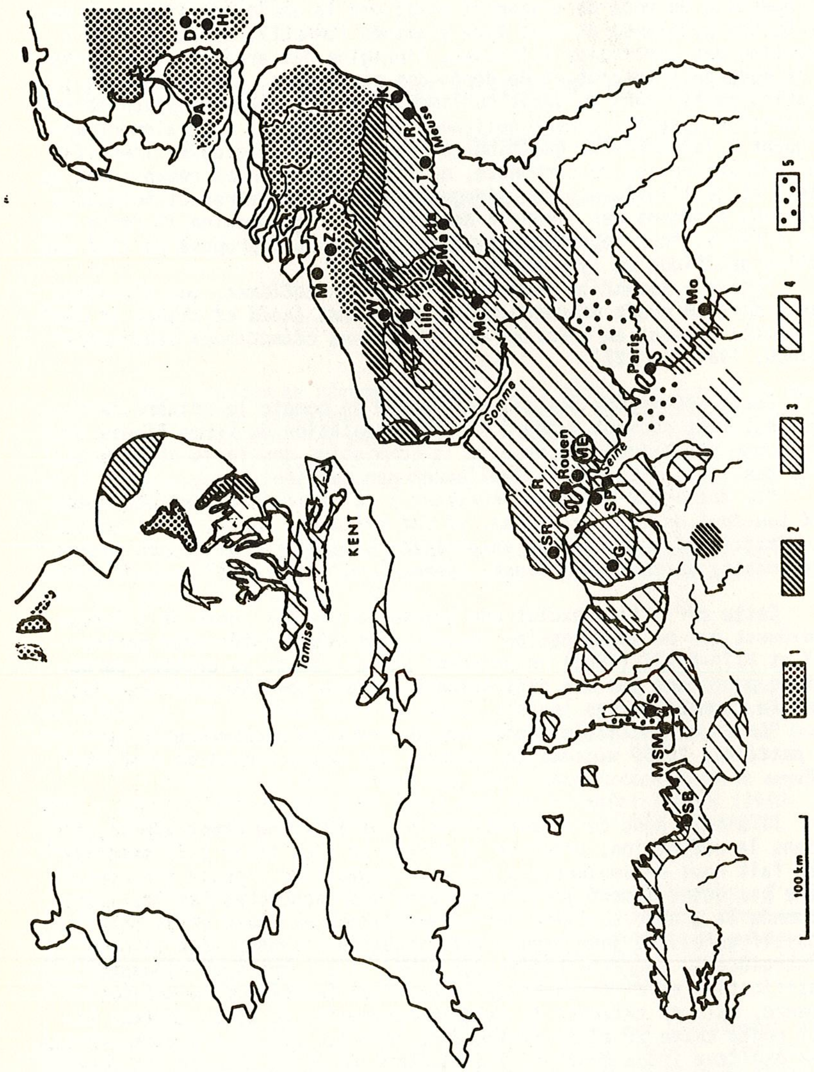
Cette définition évitait de prendre en compte le critère carbonate qui est très souvent intégré dans l'acceptation du terme "loess typique", comme par exemple le propose la Commission des loess INQUA pour la carte des loess d'Europe (actuellement non publiée) :

"Le loess est d'origine éolienne ; il consiste essentiellement en silt (surtout du silt grossier), il est calcaire, massif et ne montre aucune stratification ou litage en général, il comporte un réseau poreux de capillaires; à sec il est jaune, chamois, ou brun-jaune".

Cette définition exclut une grande partie des loess de l'Europe du Nord-Ouest qui ne sont pas (ou ne sont plus) carbonatés. Par contre SMALLEY et VITA-FINZI (1968) ne prennent pas en compte le critère carbonate et ne proposent pas une définition à la fois génétique et descriptive comme la Commission des loess :

"Loess is a clastic deposit which consists predominantly of quartz particles 20-50 microns in diameter and which occurs as wind-laid sheets".

Il s'agit donc de savoir si l'origine éolienne étant admise, il faut, dans la définition, préciser la genèse ou s'en tenir à la description. En fait nous ne voulons pas faire de dogmatisme : cette discussion n'empêche pas actuellement les progrès dans les recherches sur les loess. Etant donnée la grande activité de la Commission des loess et le rôle très positif qu'elle a joué depuis une vingtaine d'années sous la houlette énergique du regretté professeur FINK, il est pratique d'adopter sa classification en distinguant *le loess, avec la définition précédemment donnée, mais en enlevant le critère carbonate, le loess sableux bimodal (2 modes entre 20 et 60 micromètres et entre 200 et 500 micromètres), le loess argileux (plus de 25-30 % d'argile), le loess brun et les dérivés de loess (Lössderivate).* Le loess brun est un loess déposé dans un environnement plus humide, il est plus argileux et non carbonaté : de nombreux loess de Normandie correspondent à cette appellation. Les dérivés de loess comprennent les loess (comme les staublehms) ayant subi seulement des processus de pédogenèse (gleyification) et de diagenèse plus importants que le loess brun, et ceux qui ont été remaniés et amalgamés à d'autres sédiments (certains heads, loess ruisselés ...).



1 - Sables de couverture - 2 Zone sablo-limoneuse de transition - 3 loess de plus de 4 m d'épaisseur - 4 loess de moins de 4 m - 5 Sables éoliens de la Baie du Mont St Michel et du centre du Bassin Parisien

Figure 1 - Carte des formations éoliennes du Pléistocène récent en Europe du Nord-Ouest, d'après CATT, COUTARD, DEWOLF, EDEN, HELLUIN, JAMAGNE, LAUTRIDOU, MAARLEVELD, MONNIER, PAEPE, PELLERIN, SOMME, ZAGWIJN

A Amersfoort - D Denekamp - G Glos - H Hengelo - I Iville - K Kesselt - Mc Marcoing - Ma Marly - (ME) Mesnil-Esnard → Mo Montereau - M Moershoofd - Ro Rocourt - R Roumare - S Sartilly - SB St Brieuc - MSM Mt St Michel - SR St Romain T Tongrinne - W Warneton - Z Zelzate - Ha Harmignies

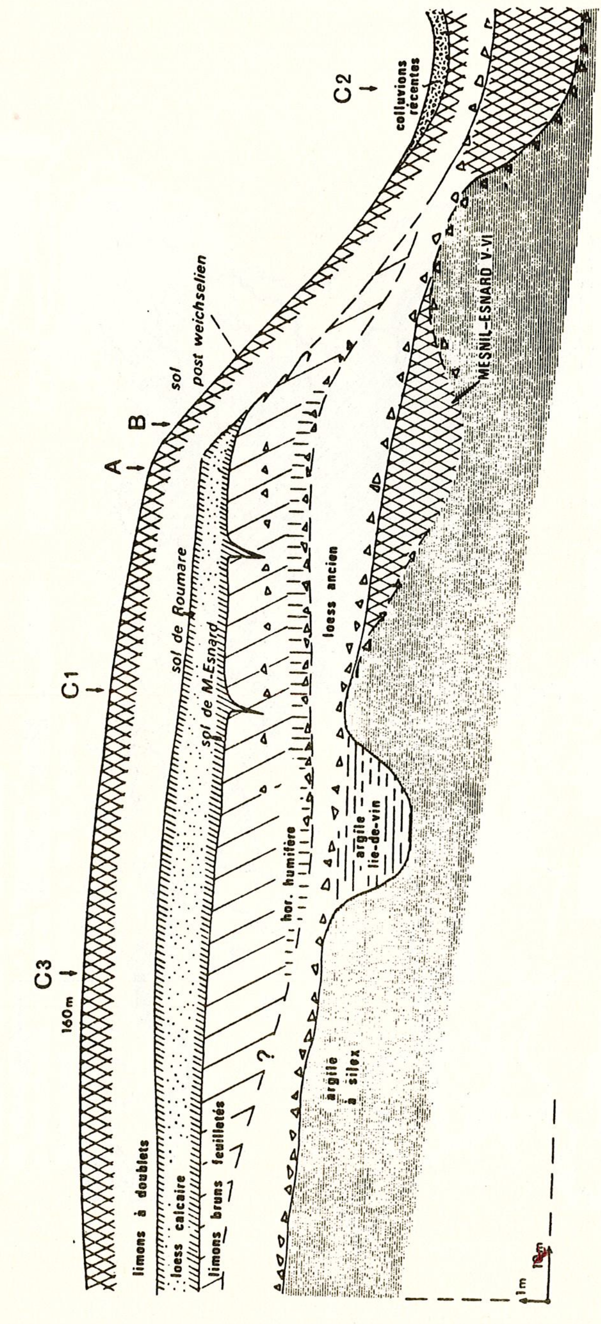


Figure 22 - Mesnil-Esnard : profil transversal au niveau des anciennes briqueteries de l'interfluve au Nord de la route nationale.

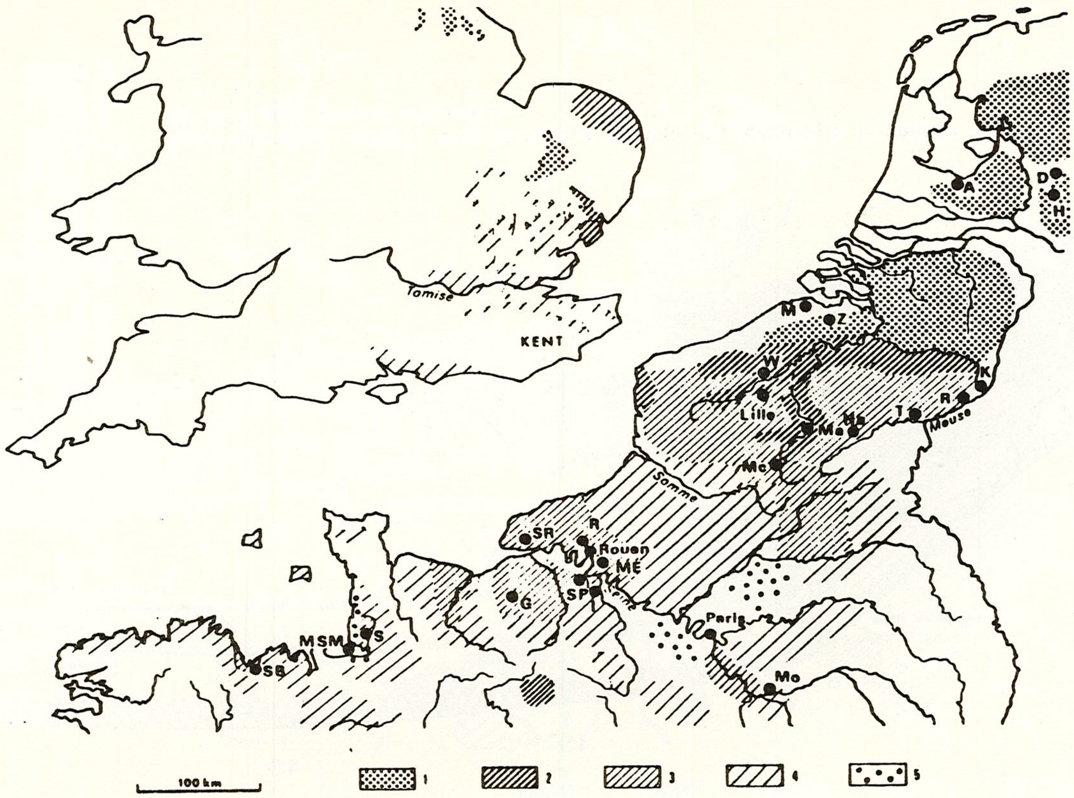


Figure 46 - Carte des formations éoliennes du Pléistocène récent d'Europe du Nord-Ouest.

1 - Sables de couverture - 2 zone de transition sablo-limoneuse - 3 loess de plus de quatre mètres d'épaisseur - 4 loess : moins de quatre mètres - 5 sables éoliens de la Baie et autour de Paris.

d'après CATT, COUTARD, DEWOLF, EDEN, HELLUIN, JAMAGNE, LAUTRIDOU, MAARLEVELD, MONNIER, PAEPE, PELLERIN, SOMME, ZAGWIJN.

A Amersfoort - D Denekamp - G Glos -
Ha Harmignies - H Hengelo - I Iville -
K Kesselt - Ma Marly - Mc Marcoing -
ME Mesnil-Esnard - Mo Montereau -
M Moershoofd - M SM Mt St Michel - R Roumare
Ro Rocourt - S Sartilly - SR St Romain -
T Tongrinne - W Warneton

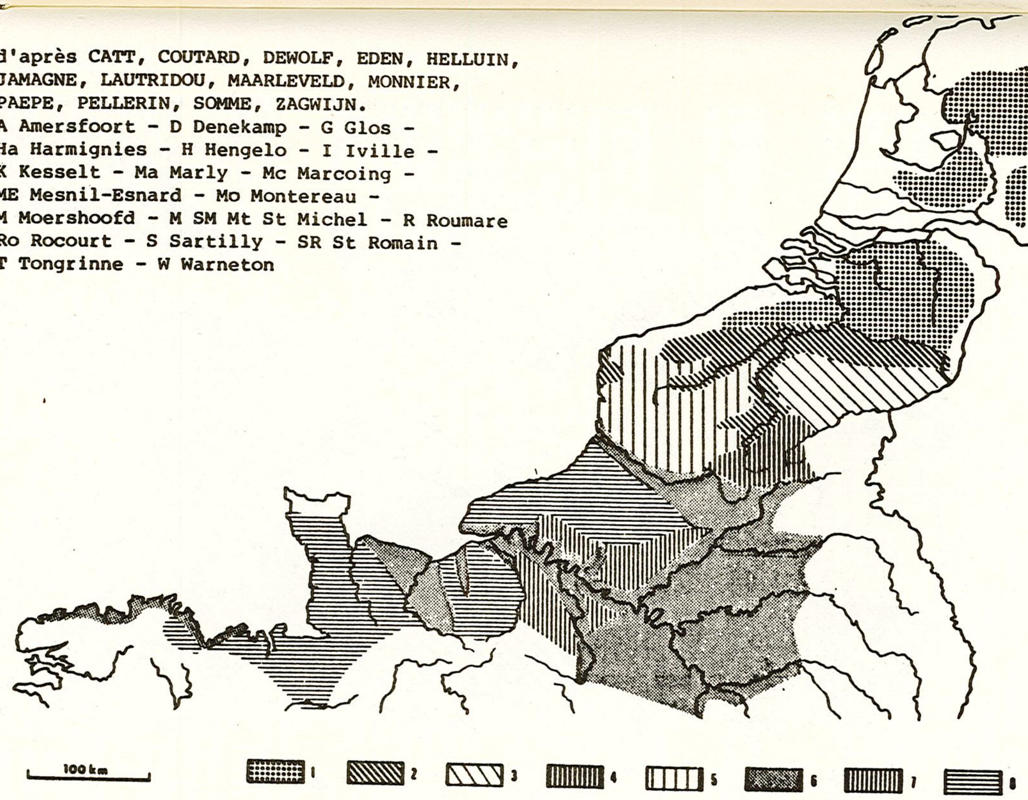


Figure 47 - Carte des provinces paléoclimatiques de l'Europe du Nord-Ouest au Weichsélien. 1 Sables - 2 Zone de transition - 3 province belge - 4 province orientale du Nord - 5 province occidentale du Nord - 6 province séquanienne - 7 province normande orientale (vexinienne) - 8 province normande occidentale.

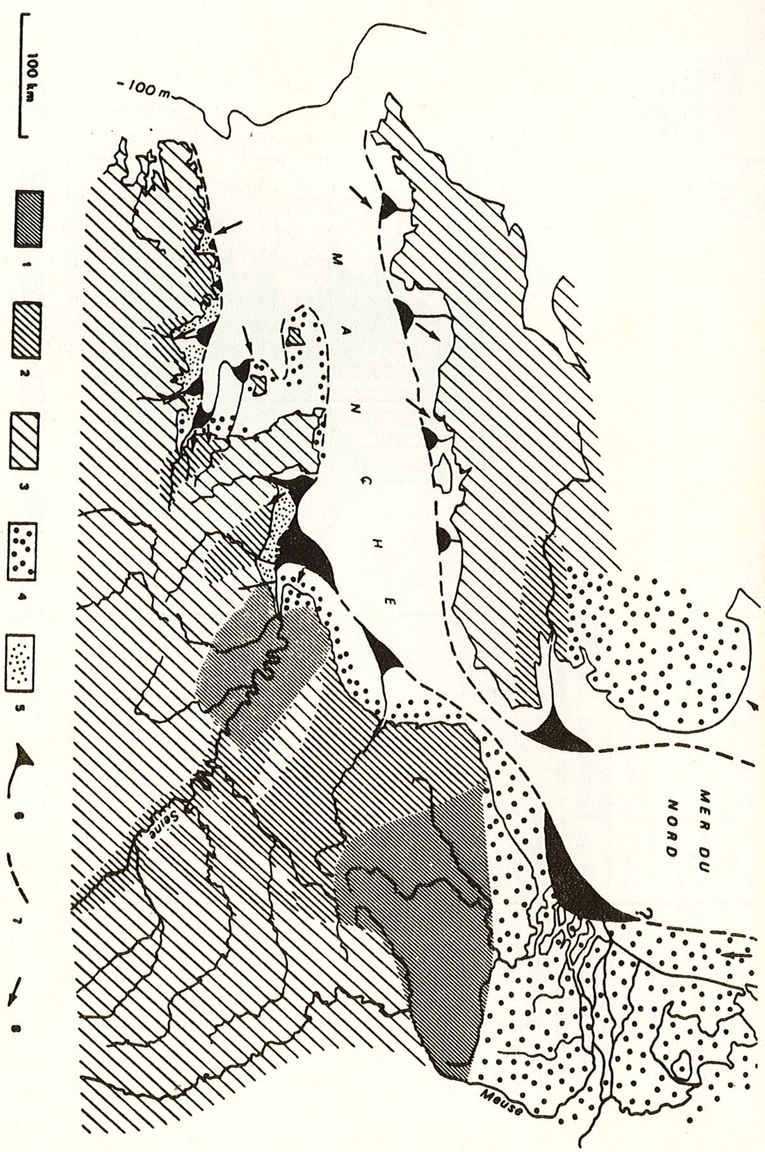


Figure 84 - Carte simplifiée des couvertures loessiques et sableuses et des provinces d'alimentation pendant le Weichsélien : 1 loess de plus de 4 m d'épaisseur - 2 loess de 2 à 4 m - 3 loess de moins de 2 m d'épaisseur - 4 Sables - 5 loess de la plate-forme marine submergés et érodés pendant la trangression flandrienne - 6 paléoestuaires - 7 - ligne de rivage associée aux paléoestuaires - 8 direction des vents nourriciers.

le Sud de l'Angleterre

La couverture loessique et sableuse est très limitée en Angleterre : elle se localise au Sud et au Sud-Est, de l'East-Anglia au Devon (Sud-Ouest) en passant par la région de la Tamise (aval) et la côte sud de l'Angleterre, le Kent en particulier (fig. 46 p. 186) d'après la carte de J. CATT (1977, 1978). De nombreuses études récentes notamment celles de J. CATT (1971, 1974) de PERRIN (1974) en East-Anglia, de EDEN (1980) en Essex (Sud de l'East-Anglia) permettent de mieux connaître ces placages restreints et peu épais excepté autour de la Tamise dans le Kent (Pegwell Bay) et le long de la côte sud (partie orientale) ; en dehors de ces deux régions il faut parler d'un saupoudrage centimétrique du type Sud de la Campagne de Caen, Est du Bocage ; très souvent l'apport éolien a été recherché dans les altérites de la craie ou au sommet de sédiments glaciaires, par exemple en East-Anglia (PERRIN, 1974).

La carte des sédiments (fig. 46, p. 186) montre une zonation nord-est/sud-ouest avec des sables de couverture et des limons sableux en East-Anglia au Nord-Est, puis des loess surtout étendus et épais entre cette région et la côte sud.

La granulométrie confirme cette zonation : il y a un gradient sédimentologique entre l'Est - Nord-Est à loess grossiers et l'Ouest à limons plus fins (CATT, 1978). Les courbes granulométriques des loess sont identiques à celles de leurs équivalents sur le continent, c'est le cas notamment du loess de la Pegwell Bay (Kent, Sud-Est de l'estuaire de la Tamise) qui contient 15 à 20 % d'argile et 10 à 15 % de sables (WEIR et *al.*, 1971). D'autres exemples précis sont fournis dans l'article sur les loess du Devon (HARROD et *al.*, 1973) et sur ceux du Yorkshire plus au Nord (CATT et *al.*, 1974). Pour éviter l'obstacle que nous avions précédemment signalé concernant les calculs d'indices (voir à Mesnil-Esnard, Pays de Caux) qui utilisent certains fractiles situés au-dessous de 0,5 micromètre, J. CATT s'arrête à 7 phi c'est-à-dire 8 micromètres (WEIR et *al.*, 1971) ; cette solution se défend, mais évidemment chaque auteur préconisant une méthode originale, les comparaisons entre loess se révèlent bien difficiles.

Au point de vue minéralogique là aussi les résultats sont surtout donnés par J. CATT et par EDEN (1980). Par exemple la fraction sableuse des loess de la Pegwell Bay (WEIR et *al.*, 1971) comporte 85 à 87 % de quartz, 6 à 12 % de feldspath, 2 % de fragments de silex, 1 à 4 % de muscovite, 0 à 2 % de glauconie et un peu de minéraux lourds ; les autres fractions (silt grossier, silt fin, argile grossière) contiennent ces minéraux en proportions différentes : moins de quartz, plus de feldspath. L'argile fine possède encore du quartz (8 à 13 %) et du feldspath (2 à 5 %) ; outre l'illite qui est le minéral argileux dominant, on signale des minéraux gonflants vermiculite-smectite et peu de kaolinite. Les minéraux lourds de la fraction sableuse sont surtout de l'épidote et de l'amphibole. D'ailleurs les loess anglais ont tous ce même cortège avec des différences attribuées à l'altitude et à l'éloignement de la source (plus de mica et de minéraux légers dans les zones les plus lointaines : CATT, 1978). Nous retrouvons l'association des loess du continent à épidote et amphiboles dominants, à grenat moins abondant et déclinant en altitude, et à zircon généralement assez important.

Les arguments cartographiques, granulométriques, minéralogiques sont donc très nombreux en faveur d'une origine des sédiments à partir du fond de la mer du Nord comme pour les loess et sables nordiques (Belgique, Pays-Bas, Nord de la France) ; en Angleterre des vents de Nord-Est auraient apporté les poussières et les sables (CATT, 1977, EDEN, 1980), mais la direction dominante demeure Nord-Sud, ce qui explique l'accumulation préférentielle en Belgique-Hollande. Toutefois nous avons du mal à croire que les loess de l'Ouest (Devon) proviennent de vents venant du Nord-Est car il faut une direction presque franchement est-ouest, alors que toutes nos données (Normandie-Bretagne) mettent en évidence des apports venant de l'Ouest, du Nord-Ouest ou du Sud-Ouest. La carte montrant la diminution de la médiane du Nord-Est vers le Sud-Ouest (CATT, 1978) présente des anomalies dans le Devon, étudiées dans un article de HARROD, CATT et WEIR (1973). En effet les loess (peu épais) du Devon diffèrent sensiblement de l'Est à l'Ouest : très grossiers à l'Est ils s'affinent rapidement vers le Devon occidental. Cette évolution serait une preuve d'une direction des vents en provenance de l'Est (ou Est - Nord-Est). Cela n'explique pas cette anomalie de loess anormalement grossiers, d'autant plus que l'altitude est élevée (180-275 m). Nous nous demandons si l'hypothèse des vents venant de l'Ouest - Sud-Ouest ne rendrait pas mieux compte de la localisation des loess d'une bonne partie de la côte sud anglaise avec des sources estuariennes locales comme en Normandie. Dans le cas du Devon l'anomalie serait liée à des phénomènes tourbillonnaires sur un littoral de forme accidenté : ils s'expliqueraient ainsi par la prise en écharpe des vents de Sud-Ouest par le cap rocheux à l'Est de Plymouth.

L'âge des loess anglais n'est pas encore bien connu mais la plupart des auteurs s'accordent à placer la sédimentation éolienne au Pléniglaciaire supérieur, après le maximum de la glaciation dévensienne (weichsélienne) vers 18000 BP. (ou commençant un peu avant 18000), ce qui pour les sables correspond aux Older Cover Sand II des hollandais. Il semblerait cependant qu'en East-Anglia on connaisse des sables plus récents tardiglaciaires : Younger Cover Sand I-II. Des essais de datations par thermolumiscence sont en cours avec A. WINTLE (Cambridge) : sur 6 échantillons traités (de Pegwell Bay surtout), ce chercheur obtient des dates oscillant entre 14800 et 18800 B.P.

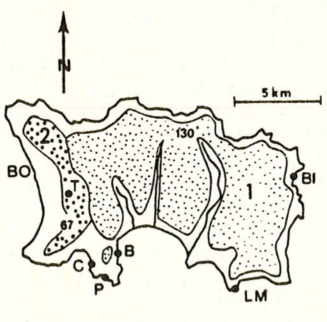


Fig. 74
Carte des loess 1 et sables éoliens 2 (sables et limons sableux) de Jersey.

Bo Baie de St Ouen
C Cotte de St Brelade
P Portelet B Belcroute
LM La Motte
Bl Belval

Chrono-stratigraphie		Phénomènes périglaciaires	NORMANDIE – LOESS – ZONE NORMANDE OCCIDENTALE	LOESS – ZONE NORMANDE VEXINIENNE	LOESS – ZONE SEQUANIENNE	SABLES – ZONE DES SABLES EPAIS	SABLES – ZONE DES PLACAGES	Phénomènes périglaciaires
TARDI-GLACIAIRE	ALLERØD					dune sol I de Genêts		
	BØLLING					sol II de Genêts		
PLENI-GLACIAIRE SUPE-RIEUR			limon à doublets III niveau de Goderville					
			limon à doublets II	LOESS SUP.	loess calcaire	sables de couverture	sables éoliens	
			niveau de Saint-Romain limon à doublets I					
			Sol de Kesselt	Sol de Roumare	niveau cryoturbé	cailloutis	graviers de Précey pavage éolien	
PLENI-GLACIAIRE MOYEN	DENEKAMP HENGELO		limon à doublets ou limon lité géliflué	loess calcaire	LOESS INF. loess calcaire loess brun oxydé	sable de couverture à cailloutis		
	MOERSHOOFD		nassböden	sol de Mesnil-Esnard				
INF.			cailloutis		cailloutis ou gélifluxion			
GLACIAIRE ANCIEN			limon brun feuilleté	limon brun feuilleté	horizon humifère horizon humifère colluvions grises	humifère sables argileux ou argiles ou head tourbe		
			cailloutis					
INTERGLACIAIRE EEMIEN			sol de Saint-Romain	sol I d'Elbeuf	sol I d'Elbeuf	Sables marins d'Annoville Sables et silts de Grandcamp		

J.P.L. 82

Tableau 40 des unités lithostratigraphiques du Pléistocène récent en Normandie, et interprétation chrono stratigraphique.

Geologické práce, Správy 82, s. 23—66, Geologický Ústav Dionýza Štúra, Bratislava, 1985

Eugénia Vaškovská

Stratigrafia a typológia fosílnych pôd mladého pleistocénu v sprašových pokryvoch na Podunajskej nížine

5 obr. v texte, 12 fotogr. tabuliek, angl. resumé

Abstract. Discussed is the new stratigraphic scheme of the Late Pleistocene of the Podunajská nížina lowland. The scheme is based on results of detailed lithogeochemical research of about 50 profiles of loessy series. On about 20 profiles micromorphological study was performed. The studied profiles represent practically all geomorphologic subcomplexes (uplands) on the Podunajská nížina. Detailed characteristic and typology of fossil soils of the R/W interglacial and of the Early Würm (Amersfoort, Brörup, perhaps Oderade) of $W_{2/3}$ (PK I) and Late Würm (Bölling, Allerod) are presented for the first time. Some soils were dated by the C_{14} method. Distinguished are two stratotypical soil complexes: the Nitra and the Vyškovce complexes. The author also presents analysis of structure and distribution of loessy covers and informs about researches with respect to stratigraphy of loessy series. Reconstruction of paleogeographic history of the Podunajská nížina during the Late Pleistocene is based on the generalized data and on the new stratigraphic scheme.

Na Podunajskej nížine boli geomorfologické celky a ich časti (podľa regionálno-geomorfologického členenia E. Mazúra—M. Lukniša 1980): Trnavská, Nitrianska, Žitavská, Hronská a Ipeľská pahorkatina (obr. 1) so svojráznym typom reliéfu počas kvartéru arénou tvorby sprašových pokryvov. Priestorové rozšírenie pokryvov je úzko späté s topografickou situáciou v rozmedzí od 110 do 300 m n. m. Vyššie, nad hornou topografickou výškou, najmä v okrajových častiach pahorkatín smerom k lemujúcim pohoriam, prechádzajú spraše obyčajne do sprašových derivátov. Uvádzaná hypsometrická závislosť rozšírenia spraší, najmä mladého pleistocénu, nie je jednoznačná, na čo poukazuje skutočnosť, že spraše z nížin prechádzajú do okolitých pohorí, napr. do Považského Inovca, Malých Karpát, Tríbča a pod., kde ich potom môžme nájsť s redukovanými hrúbkami približne do výšky 400 m n. m. Hrúbky sprašových pokryvov na pahorkatinách Podunajskej nížiny alebo riečnych terasových stupňoch nie sú rovnaké. Na Trnavskej pahorkatine, ako uvádza I. Vaškovský (1970), bývajú hrúbky sprašových pokryvov priemerne okolo 8—12 m, maximálne do 35 m; na Nitrianskej pahorkatine v jej strednej a dolnej časti sú priemerné hrúbky sprašových pokryvov okolo 8—12 m, maximálne do 30 m; na Žitavskej pahorkatine dosahujú okolo 12 m; na Hronskej pahorkatine, v jej strednej a dolnej časti, sprašové pokryvy dosahujú, ako uvádza J. Harčár (1967), okolo 10—12 m; v okolí Svodína až 40 m. Najčastejšie hrúbky spraší na Ipeľskej pahorkatine sú 5—8 m, v okolí Levíc okolo 25 m. Na strednom terasovom stupni Dunaja, medzi Komárnom a Štúrovom, dosahujú hrúbky spraší 8—15 m; podobné hrúbky sprašových pokryvov možno pozorovať aj na terasových stupňoch tokov Váhu, Nitry, Žitavy, Hrona a Ipľa.

Aj keď na prvý pohľad tvoria sprašové pokryvy na Podunajskej nížine pomerne jednoduché morfologické útvary, v skutočnosti býva ich vnútorná stavba zložitá. Zložitosť stavby odráža vplyv viacerých procesov denudačných, sedimentačných, pôdotvorných a ďalších vo vzťahu k intenzite klimatických zmien počas kvartéru, reliéfu podložia atď. Vzhľadom na charakter zložitej vnútornej stavby môžeme sprašové pokryvy rozdeliť na jednoduchšie a zložitejšie.

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E. Vaškovská

On Stratigraphy and Typology of Late Pleistocene Fossil Soils in Loessy Series of Podunajská nížina (Danube Lowland)

Summary

Geomorphologic subcomplexes distinguished in the Podunajská nížina (Danube lowland), i.e. the Trnavská, Nitrianska, Žitavská, Hronská, Ipeľská pahorkatina uplands were characterized by extensive formation of loessy covers during the Quaternary time (Fig. 1). The extension of the covers is associated with hypsometric levels from 110 m to 300 m above sea level. Higher up the loesses pass into loessy derivatives and exceptionally into the surrounding mountain ranges Malé Karpaty, Považský Inovec, Tríbeč, a.o. There the loesses occur 400 m above sea level. Thicknesses of the loessy covers are variable and range up to 40 m. Geologic maps show the areal extent of Late Pleistocene loesses of variable thickness (1—15 m).

The study of loesses in the Podunajská nížina began at the beginning of this century (mainly E. Horuszitzky and Timko). Systematic investigations of loessy series in the lowland have been performed since the World War II. by M. Lukniš, V. Ambroš, V. Ložek, F. Prošek, J. Pelíšek, J. Tyráček, J. Šajgalík, J. Kukla, J. Bárta, J. Bedrna, J. Košťálik, J. Harčár, R. Halouzka, Z Schmidt, J. Pristaš, J. Hraško, I. Vaškovský a.o.

The author of this article has been performing thorough lithogeochemical and micromorphological researches at about 100 profiles of Quaternary sediments in the entire Carpathian region of Slovakia. About 50 profiles of the loessy series and fossils soils represent practically all geomorphologic subcomplexes and parts of the Podunajská nížina (Fig. 1). The age of some Late Pleistocene fossil soils was determined by the C_{14} method, and paleomagnetism was applied as well.

Data resulting from the study of loessy series with particular respect to paleosoils served as a basis for the new stratigraphic scheme of the Late Pleistocene in the Podunajská nížina (Fig. 2). The scheme denies the stratigraphic scheme presented by R. Halouzka (in R. Halouzka—Z. Schmidt 1979, 1981) with wrong typology of fossil soils and their erroneous stratigraphic ranging in the R/W interglacial and in the Early Würm.

The base, i.e. the beginning of the Late Pleistocene is the R/W interglacial, represented in loessy series in the Podunajská nížina mostly by fossil soils. The soils formed mainly under automorphic conditions (Fig. 3, 4). Another, less frequent group is represented by hydromorphic soils which formed in fluvial flood-plain sediments, under a considerable influence of groundwaters (Fig. 5).

Two types of soils were distinguished in the first group of automorphic R/W fossil soils of the Podunajská nížina:

1. illimerized soils (Parabraunerde) studied in detail at the localities Mnešice, Trakovice, Veľké Kostolany, Trnava, Báb, Alekšince, profile IV; Kovárce, Divá, Veľké Ludince, Veľké Lovce, Šahy (Pl. I, Fig. 1, 2, 3; Pl. II, Fig. 1, 2). Fossil soils of this type were thoroughly studied at the locality Báb (3.1—4.4 m).

2. The second type of the automorphic soil group of the R/W interglacial in the Podunajská nížina is represented by the soils of the brownearth type. They are characterized by intrasoil weathering of a high grade. These soils occur on the localities: Moravany, Banka, Vlčkovce, Veľké Lovce, Divá, Veľké Ludince. On the locality Veľké Lovce the bottom soil represents only a small part of the R/W soil, since the later superposed chernosem formation affected the major part of the original R/W soil. The soil around Kubáňovo (profile Kubáňovo I and II) is somewhat particular (Pl. III, Figs. 1, 2; Pl. 5, Figs. 1, 2). I suppose that the formation of the R/W soil was followed later in the Early Würm by minimal or no deposition of loesses and so the later soil-forming processes during the Amersfoort and perhaps also during the Brörup proceeded on the original soil (it is indicated by the character of new formations, carbonates, a.o.). Detailed characteristic of the R/W soil of the brown soil type on the locality Kamenica (profile KH-1) is presented (Pl. I, Fig. 4).

Another group of soils of the R/W interglacial in the Podunajská nížina (lowland) are represented by hydromorphic soils on the localities Vyškovce II (Pl. IV, Fig. 1, 2) and Kamenica n. Hronom. Detailed characteristic of fossil soils on the locality KH-4/Vb in the surroundings of Kamenica is presented (Pl. VI, Fig. 1, 2, 3, 4). The soil developed on the flood-plain sediments of the middle terrace of the river Hron at the depth 8.25—9.5 m.

Early Würm (W1). According to the submitted new stratigraphic scheme it comprises the periods of W1, Early (W1 ol. — the 1[st] stadial of the Würm glacial), the Amersfoort (Am) interstadial (the 1[st] interstadial of the Würm glacial — PK II_1, the 2[nd] stadial of the Early Würm — W1 Late (W1 y.) and Brörup interstadials (Br) — PK II_2.

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LES LOESS DU PLÉISTOCÈNE SUPÉRIEUR EN BELGIQUE ; COMPARAISONS AVEC LES SÉQUENCES D'EUROPE CENTRALE

■

par Paul HAESAERTS*

RÉSUMÉ

Les recherches récentes relatives aux loess du Pléistocène supérieur en Europe du Nord-Ouest et en Europe centrale ont montré que dans ces différentes régions la couverture loessique principale s'était mise en place entre ± 25 000 et ± 20 000 B.P., soit avant la dernière extension maximum de l'inlandsis scandinave. En Europe centrale, la sédimentation loessique s'est néanmoins poursuivie localement jusqu'à la fin du Weichsélien.

Mots-clés : Loess, Weichsélien, Archéologie.

ABSTRACT

THE UPPER PLEISTOCENE LOESSES OF BELGIUM ; COMPARISONS WITH THE SEQUENCES OF CENTRAL EUROPE

Recent research on the Upper Pleistocene loessic formations of northwestern and central Europe have shown that in both regions the main loess cover has been deposited between ± 25 000 and ± 20 000 B.P., essentially before the last maximum extend of the scandinavian ice sheet. Nevertheless, in some areas of central Europe the loessic sedimentation was active up to the end of the Weichselian.

Key-words : Loess, Weichselian, Archaeology.

1. — INTRODUCTION

Les formations limoneuses de Moyenne Belgique ont enregistré l'essentiel des événements sédimentaires et climatiques du Pléistocène supérieur et constituent de ce fait une séquence de référence pour le Nord-Ouest de l'Europe. Le contexte chronostratigraphique de cette séquence s'appuie classiquement sur les relations avec les systèmes de terrasses et sur les interprétations climatiques déduites notamment des paléosols, des phénomènes périglaciaires et des données palynologiques ; interviennent également quelques datations ^{14}C dont certaines sont associées à des occupations préhistoriques (Haesaerts, 1984, Haesaerts *et al.*, 1981).

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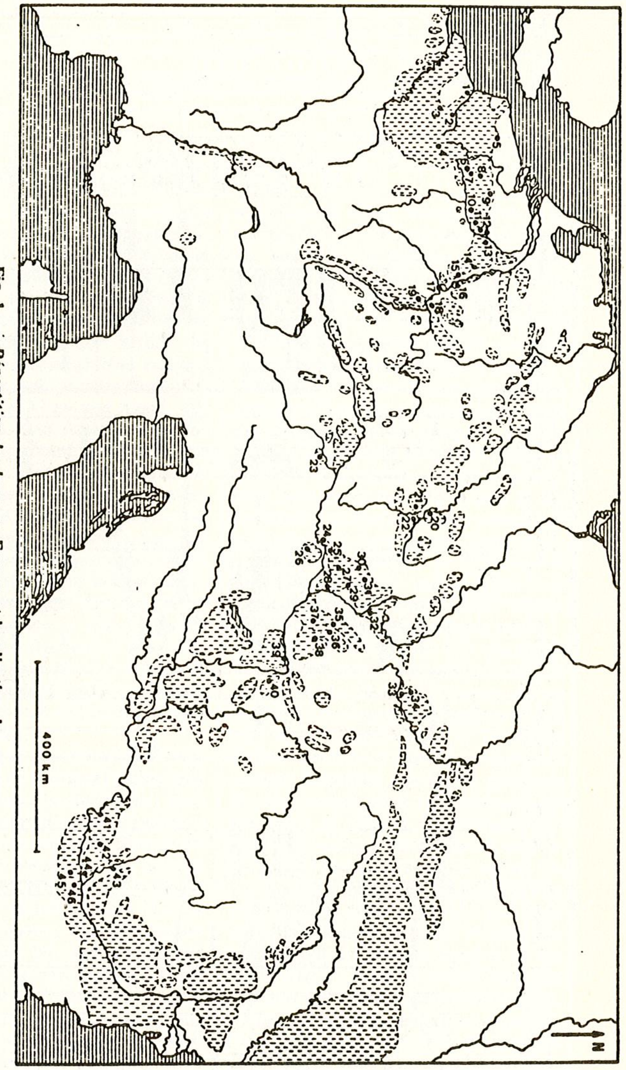

Fig. 1. — *Répartition des loess en Europe et localisation des coupes.*
Nord de la France. 1) Boismont ; 2) Corbie ; 3) Sourdon ; 4) Ribemont. ***Belgique.*** 5) Poperinge ; 6) Harmignies ; 7) Maisières-Canal ; 8) Le Clypot ; 9) Wezembeek Oppem ; 10) Huccorgne ; 11) Rocourt ; 12) Kesselt, Lixhe et Opgrimbie. ***Pays-Bas.*** 13) Nagelbeek. ***Allemagne.*** 14) Brühl ; 15) Ringen ; 16) Ariendorf ; 17) Rhems ; 18) Wiesbaden ; 19) Sprendlingen. ***Bohême.*** 20) Litomerice ; 21) Prague (Letky) ; 22) Chabry. ***Autriche.*** 23) Altheim ; 24) Willendorf et Aggsbach ; 25) Krems et Paudorf ; 26) Feilendorf ; 27) Hollabrunn ; 28) Stillfried. ***Moravie.*** 29) Dolni Vestonice et Pavlov ; 30) Vedrovice ; 31) Bohunice (Brno) ; 32) Predmost. ***Pologne méridionale.*** 33) Zwierzyniec et Spadzista ; 34) Brzoskwinia. ***Slovaquie.*** 35) Nove Mesto ; 36) Moravany ; 37) Vlckovce ; 38) Nitra. ***Hongrie.*** 39) Basaharc ; 40) Mende et Tapiósüly. ***Roumanie.*** 41) Cetate ; 42) Craiova ; 43) Slatina ; 44) Grojdibod. ***Bulgarie.*** 45) Dolni Vit ; 46) Mousselievo.

Fig. 1. — Distribution of loess in Europe and localisation of the main sections.

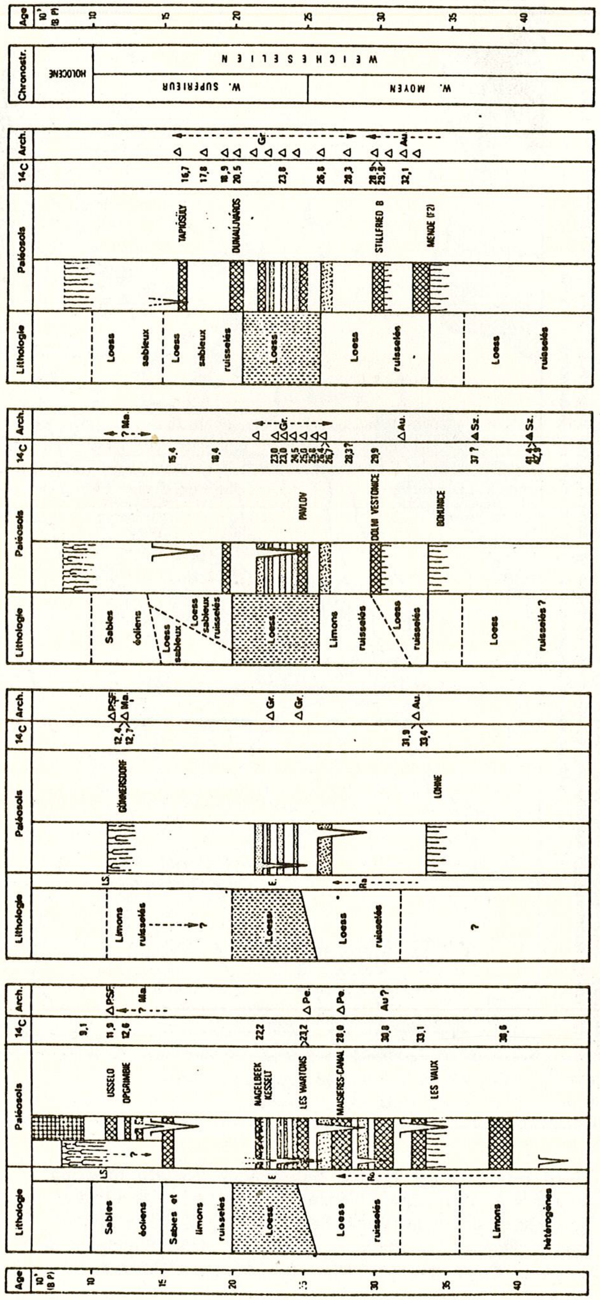

Fig. 3. — Séquences loessiques de la seconde moitié du Weichsélien en Europe occidentale et en Europe centrale (légende des symboles, voir figures 2 et 4)

Fig. 3. — Loessic sequences of the second part of the Weichselian in northwestern Europe and central Europe (symbols : see figures 2 and 4)

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The loess region of China

DELEGATES from ten overseas countries recently attended the international symposium on loess research held in Xi'an, in the People's Republic of China (5–13 October, 1985), the first such meeting to be held in the classic Chinese loess region.

A 5-day field excursion before the meeting traversed several loess regions, distinguished by their geomorphological features, between Xi'an and Ansai, 400 km to the north. Our route crossed the broad Wei River flood plain which is mantled by loess and dissected by a few small gullies. Northwards, the hill country is dominated by long, loess-covered ridges termed liang. Limestone quarries along the road gave a unique opportunity to observe how the liangs are related to the underlying bedrock. Smaller, loess-covered hills, known as mao, separate this area from the flat-topped loess plateau, termed yuan. Here the loess is about 100–200 m thick and is extensively cultivated with wheat and maize, a little cotton and tobacco.

The most spectacular features of these yuans are the deep erosional gullies that dissect the plateau. In particular, near Luochuan, the gully is some 130-m deep and in the near-vertical cliffs a sequence of more than 15 palaeosols can be seen overlying the basal red clay. One site has been studied for about 30 years and the chronological sequence has been established primarily by palaeomagnetic measurements of a core nearby. These results imply that the 130-m deep section spans the last two magnetic epochs, the Brunhes and the Matuyama. Detailed magnetic stratigraphies reaching back into the Gauss normal epoch (Heller, F. & Liu, T-s *Nature* 300, 431; 1982), indicate that loess deposition may have started as early as 2.66 Myr ago. This is similar to the 2.9 Myr date reported by G.J. Kukla (Lament-Doherty, Geological Observatory) for the beginning of non-biogenic silica incorporation in a marine core off the Japanese coast. Similar and more continuous records are expected from the Qaidam Basin, closer to the source area of the loess, and it is tempting to correlate the palaeosols with the interglacial periods revealed by the deep-sea oxygen-isotope record.

Another feature of the symposium was the integration of geotechnical and chronological studies of loess. A large number of physical properties, such as the bulk dry-density and liquid limit, have been measured and related to the probability of landslides and collapse of loess when it is waterlogged. These properties are of interest as the area is bounded by major active faults and records document many major earthquakes in the past two thousand years.

A highlight of the field trip was a visit to an experimental conservation area, in Ansai County, Shaanxi Province, set up in 1980 by the Northwest Institute of Soil and Water Conservation of Academia Sinica. Erosion of the loess and subsequent landslides are major problems for agriculture, road maintenance and the safety of villages. Experiments designed to measure water run-off and removal of loess have been set up on the top of a hill overlooking the field station, and different types of shrubs and trees have been planted to try to stabilize the surface. We are also privileged to be the first foreigners to visit a village where the results of this research have been applied. Higher crop yields and more terracing have enabled the villagers to cover the upper slopes with trees and leguminous plants, which protect their livelihood.

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PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON LOESS RESEARCH

.CHINA QUATERNARY RESEARCH ASSOCIATION
INSTITUTE OF GEOLOGY, XIAN BRANCH AND
XIAN LABORATORY OF LOESS AND QUATERNARY
GEOLOGY, ACADEMIA SINICA
INQUA COMMISSION ON LOESS

OCTOBER, 1985, XIAN, P.R.C

REMARKS ON THE LOESS TYPES IN ROMANIA

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The study is a general account of loess and loess-like deposits occurring on Romanian territory. These formations cover large areas in the southern part of the country (Romanian Plain and Dobrogea) or restricted areas belonging to different other geological units.

Recent detailed investigations have concerned the delimitation of some lithological types and the possible relationships between them and the genesis of loess types.

The loess was delimited from loess-like deposits by consider - ing, first of all, the lithological criteria. Starting from obvious differences and taking into account the different Pleistocene geological evolution of some morphostratigraphic units, several lithological loess types and loess-like deposits were distinguished.

The map of the areal extent and thickness (5-50 m) of different loess types and loess-like deposits was drawn.

The study includes some results regarding the loess chronology. Therefore, starting from typical loess and paleosols sequences paleamagnetic studies were achieved. According to the results obtained, the loess and paleosols in Romania are assigned to the Brunhes polarity epoch.

SEDIMENTOLOGY AND MAGNETOSTRATIGRAPHY OF THE LOESSIC SUCCESSION AT SAINT VALLIER, ISERE, FRANCE: PRELIMINARY RESULTS

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The Saint Vallier site, situated some 50 km south of Lyon was excavated anew in March 1985, providing detailed description and samples from the full thickness of over 6 m of loess - like silts resting upon a gravelly red clay considered to be of Pliocene age. The work of Viret (1954) and Bourdier (1963)established, on the basis of the mammalian bone assemblage near the base of the section considered to be Villafranchian in type,that this may be the oldest loess-like sediment in western Europe.

Preliminary scanning electron microscopy shows many angular quartz silt grains in addition to feldspars weathered to varying degrees, and substantial translocation of clay-grade material. Thus the deposit has very poorly sorted values (2.1-2.9:Folk and Ward 1957) with values of >3.2 in the palaeosols. Local microlamination suggests limited reworking on the slope but frost - induced ped-forms and fragipans have not been recognised. The silt may therefore be a little-disturbed aeolian deposit (i.e. true loess). Two important indurated layers at 2 m and 5.5 m depth are strongly cemented, calcite mantling the silt skeleton. Authigenic aragonite is abundant in certain parts.

Detailed measurements of remanent magnetisation (declination and inclination) were made on the lowermost 4.5 m of the section with some scattered measurements in the upper 1.75 m. The magnetisation is clearly reversed at 1.75 m depth but is intermediate and possibly unstable above. The lower part of the section is much clearer, however. Starting at the base, the whole of the 4.5 m analysed is reversed with an excursion 3 m above the base. The very bottom is normally magnetised and is interpreted as the Matuyama-Gauss boundary (2.48 Ma), and we speculate that the short normal section 3 m above the base is the Olduvai normal chron (

1.67-1.87 Ma). This appears to confirm that the Saint Vallier site contains the oldest known loess in Europe. It is comparable in age with that extrapolated for the classic Chinese site at Luochuan (Heller and Liu 1982) and, unless it is shown that the Lanzhou section contains important hiatuses, Saint Vallier may be older than the basal loess at Jiuzhoutai (see abstract by Derbyshire, Wang and shaw this volume).

INTERIM RESULTS OF STUDIES OF THE SEDIMENTOLOGY AND REMANENT MAGNETISATION OF THE LOESS SUCCESSION AT JIUZHOUTAI, LANZHOU, CHINA.

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Seventy oriented samples extending over the full 315 m of loessic silt in the mountain Jiuzhoutai near Lanzhou city in the Gansu Province of China have been examined and preliminary analyses of grain size, sedimentary fabric and remanent magnetisation completed.

The silt rests upon imbricated gravels of the fifth terrace of Huanghe (Yellow River), the lowermost 35 m showing clear evidence, in the form of lamination and bedding, of alluvial reworking. The upper c. 40 m is relatively coarse with a fragile fabric locally strenghened by cementation, predominently of calcite. Below this , the silt is rather fine, compact and often strongly cemented. There is some evidence at depths in excess of 250 m of cementation and precipitation on grain surfaces of amorphous silica, suggesting pressure solution. Evidence of disturbance by frost is hard to find, although the Upper Pleistocene (Malan) loess contains limited evidence of silty cappings & sub-horizontal orientations reminiscent of freeze-thaw segregation. Bioturbation, associated with areas of CaCo deposition, is relatively rare, but up to 10% of Malan loess consists of detrital aggregates derived from red soils (eroded interglacial surfaces ?).

Both declination and inclination have been measured in a cryogenic magnetometer. Although magnetisation is weak in some samples, there are clear normal and reversed segments. The upper normal section (Brunhes) is clear but if it is assumed that it extends for 730,000 yr then the remaining 255,000 yr (linear extrapolation) does not agree with the standard published polarity time scale. It is inferred that there must be several erosional hiatuses in this succession. A large proportion of the Matuyama appears to be missing (? 0.73-1.5 Ma). One possibility raised by this hypothesis is that the last two normal events are Reunion 1 and 2. If this is so, the base of the section may extend back in time to about 2.2 Ma, bringing the Jiuzhoutai profile approximately in line with the classic succession at Luochuan, but leaving it younger than the base of Saint Vallier loess in southern France (see Billard, Derbyshire and Shaw, this volume). Evaluation of erosional hiatuses is thus critical to the confirmation of the magnetostratigraphy at Jiuzhoutai.

HOLOCENE LOESS OF CHINA

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Holocene loess of China was developed all over the loess belt, including the northwestern inland basins, the central loess plateau and the eastern mountain foothills and plains with best development in the area of the middle reaches of the Yellow River. Holocene loess in the middle reaches of the Yellow River can be subdivided into three formations composited commonly of upper loess and lower dark loessial soil, which was developed on underlying loess parent material. Varying layers of dark loessial soil contain different spore -pollen assemblages with ages of 2000-3000, 4600-7400 and 8100 -9900 yrs B.P. respectively. Additionally, according to climate-stratigraphic corelation, it can be deduced that another younger dark loessial soil may be existence in the area of the middle reaches of the Yellow River with gae of 500-1500 yrs B. P.. Such a layer of dark loessial soil is possible to be an independent unit or a pedogensis superimposition on ancient soil layer. The layers of dark loessial soil at similar stratigraphic levels in different localities show such a change in age that samples from south are older than those from north, indicating a northward shift of the climate belt during pedogensis.

STRATIGRAPHY AND CHRONOLOGY OF LOESS DEPOSITS IN THE AWATERE VALLEY, SOUTH ISLAND, NEW ZEALAND

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Loess-mantled, tectonically uplifted and tilted river terraces from the dominant landscape feature of the lower Awatere Valley in the north-east of the South Island.

Seven loess layers, having a total thickness of about 20 m have been distinguished near the mouth of the Awatere River. Individual layers were distinguished by morphology and abundances of major elements, especially potassium; importantly the base of each layer is marked by the downwards transition from relatively few to many soil features and by a decrease in potassium concentrations.

Dust blown off the broad, braided, gravel flood-plain of the Awatere River is accreting as loess on terraces close to the river at present as deduced from relationships of loess beds to terrace alluvium. Loess accumulation may have been a continuous process in the lower Awatere Valley throughout the late Quaternary. The main accumulation episodes would have occurred while the river occupied somewhat more extensive and more sparsely vegetated flood plains than those of the present day.

The presence of the c. 20,000 years B.P. Kawakawa Tephra within what is considered to be the main depositional bed of the uppermost loess layer (layer 1) indicates that this loess bed accumulated under cold climate conditions. Loess layer 1 is judged to have commenced accumulating at about 25,000 years B.P., from the stratigraphic position of the Kawakawa Tephra datum within the loess. The onsets of accumulation for the older loess layers 2 and 3 are estimated using floodplain relation diagrams while the bases of loess layers 4,5,6 and 7 are matched with the onsets of cold climate conditions recognised from the oxygen isotope and sea level records.

Within the oldest three loess layers, three tephric horizons have been recognised from concentrations of volcanic glass. These tephric horizons have been correlated, from the major element compositions of their glass shards, with North Island tephras of known age, and therefore provide a time framework for the lower part of the stratigraphic column. The oldest tephric datum is the 240,000 ± 50,000 years B.P. Mount Curl Tephra which occurs in the lowermost loess layer (layer7).

The presence of the Kawakawa Tephra and Mount Curl Tephra datums within Awatere Valley loess has permitted a comparison with North Island loess columns. Six loess layers have been distinguished above the Mount Curl Tephra in the Awatere Valley and between five and six layers have been inferred to overlie the Mount Curl Tephra in the southern North Island.

THE ORIGIN OF YOUNG PLEISTOCENE LOESS OF THE WESTERN REGIONS OF FRANCE

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For a long time, the origin of silt constituting the principal loess stock of Northwestern Europe has been suggested notably as glacial or periglacial deposits. The cartography of these loess shows that they come from the provinces situated under the English Channel at the present time. But these submarine regions do not seem to be glacially originated because nor the Rhine nor the Meuse River, which could have transported these nordic glacial materials, do not pass by The Channel according to the results of recent geological studies of submarine formation.

The influence of frost shattering is evident: all of our experiments on gelifraction show that the effect of frost on rocks and minerals (including quartz) produces a small amount of silt. But the principal source is furnished by the original armorican marine sediments which were migrated in the English Channel towards the East, particularly in the interglacial period : as result the mineralogical stock of these young loess (epidote, amphibol, garnet, smectite) is that of marine formations.

Moreover, the detailed cartography of these zones of loess shows that the provinces of origin are numerous and well localized. They are in good relation with the river downstreams, and well correspond to ancient estuaries situated between -20 & -30 meters under the actualsea level. The question now is whether these were the estuaries abandoned by the sea during the marine regression of Weichselian or the sea was at that level during the periglacial phases of loess deflation.

THE LOESS OF CENTRAL AND WESTERN BUENOS AIRES PAMPAS, ARGENTINA

Jorge Rabassa and Fernando De Francesco
C.I.C. & Direccion de Geologia de la Provincia de Buenos Aires

The Buenos Aires Pampas are extended, grassy plains with almost no regional slope, in which two sub-parallel, NW-SE trending ranges, separated by 300 km, are emerging. These ranges are Sierras de Tandil and Sierra de la Ventana and they are formed by Precambrian metamorphics and sedimentary rocks both of Upper Precambrian and Paleozoic age. These hilly ranges are surrounded by piedmont and aeolian deposits.

The loessic sediments of this region include a sequence of lithostratigraphic units that extend from the Early Pliocene (perhaps even from the Late Miocene) to the historical times and the Little Ice Age (XVIIth to XIXth centuries). These units are clayey silts to sandy-clayey silts in the older units with a gradual change to sandy silts and silty, very fine sands in the younger, Late Pleistocene and Holocene units.

Calcium carbonate (locally called "tosca") is a common epigenetic deposit in these units, specially those of Pliocene and Early Pleistocene age, both in the shape of "loess dolls", concretions, veins, scattered cementing dust or as in extensive sheets or duricrusts with thickness of 1-3 m. There is no clastic calcium carbonate, except for those particles re-deposited from old "tosca" outcrops, under the action of mass-movement processes. The epigenetic calcium carbonate is interpreted as formed in arid- or semiarid environments, during pedogenetic processes and /or by evaporation from the soil. The abundant fossil remains, mainly mammals, indicate as well that the environmental conditions during their accumulation were less humid than present times.

The loess is composed, in its sandy and coarse silty fractions, largely by volcanic minerals and volcanic glass shards, which are allochtonous to this area; they come from the Andean and Patagonian regions, W and SW of the Pampas, respectively, and more than 1000 km away. There are, however, other materials of local origin, derived from the igneous, metamorphic and sedimentary rocks of the Buenos Aires ranges. The clay-size minerals are basically montmorillonite and illite, with minor contents of kaolinite, quartz and interstratified clay minerals.

The grain-size, the allochtonous origin of the sand - coarse silt clasts, the almost unexistant rounding of the glass shards, the unweathered character of most of the sand clasts, the lack of stratification and the regional setting of these sedimentary bodies which overlie uncomformably and homogeneously pre-existing continental and/or littoral landscapes, are the most important criteria that have been widely used in Argentina to define the aeolian origin of these units and to name them as loess.

The faunal remains of arid- and semiarid climates, the calcium carbonate deposition as pedocalcic paleosols, the geographic setting and the pre-Quaternary age of some of these units suggest the genesis of these loessic formations is peridesertic and not periglacial as it happens in Europe and North America. Nevertheless, the paleoclimatic implicancies of the accumulation of these aeolian beds in the semiarid lowlands of the Pampas while the Patagonian Andes were extensively covered by the Pleistocene (even Late Pliocene?) mountain ice-sheet should not be neglected.

ON LOESS LANDSLIDES IN TIANSHUI, GANSU PROVINCE

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The occurrence of landslide in Tianshui region is extremly frequent, repeatedly and active. Since 193 B.C. only recorded large-scale landslides are more than 300 cases. In the area of concentrated districts landslide occupied the total area of playing as a typical landslide region on loess plateau.

There are three conditions leading to landslide occurence: (1) being duality superimposition of strata, i.e. the Tertiary red clay is covered by loess clearly and their interface best developed; (2) erosion and transmigration of soil were intensified by human-activities and defrostation with annual erosional deepth up to 0.2-0.5 m; (3) continuous activity of earth crust with annual amititude of about 0.6-0.8 mm. There are two factors leading to landslide occurrence: (1) earthquake, as larger than 6 degree, it may lead to landslide occurrence, such as those in 1654, 1718, 1868, 1920 and 1963 are nearly 340 places, the largest area covers an area of 17 km^2; (2) precipitation thin loess (20-30 m) in Tianshui region, and close relationship between landslide and precipitation are the important factors. There are more than 20000 cases of landslides due to torrential rain in 1981 and 1984. Landslide occur when precipitation is more than 100 mm per hour, or six days over 60 mm and precipitation amount up to 50mm/hour in rain precipitation years.

The cycle of earthquke landslide is about 30-50 years. occuring mostly in June. The cycle of precipitation landslide is about 6-12 years occuring mostly (about 60%) in July-August.

PROBLEMS OF EARTHQUAKE ENGINEERING GEOLOGY OF LOESS SITES AND THEIR ESTIMATING METHODS

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In northwest China, loess and loess-like deposits are widespread and most of the regions covered by loess or loess - like deposits are also situated in seismic active zones. The experience of historical strong earthquake indicates that under the same earthquake magnitude conditions, earthquake damage in the loess regions was apparently heavier than in the other regions , but for a long time, the reason of such effect of loess site on earthquake damage has not been well understood. We think that the essential factors the dynamic properties of loess and the geological conditions of the loess regions.

In this paper, the experiences of earthquake damage in loess regions in China and other countries are systematical summarized. On the basis of these experiences, some important problems of earthquake engineering geology in loess regions are studied. Some quantitative estimating methods about these problems are presented. This paper brings some approaches to go further into these problems which have not been well studied.

The problems studied in this paper are as follows.

(1) The dynamic properties of loess: Some experimental results of dynamic triaxial test about loess or loesslike soils are introduced. These properties of loess are closely related to the earthquake damage.

(2) Characteristics of ground motion during strong earthquake in loess regions: The effects of loess site conditions on earthquake ground motion and earthquake damage are tentatively explained by finite-element analysis.

(3) The effects of topography and geomorphic condition of loess regions on earthquake ground motion and earthquake damage.

(4) The problem of slope stability during strong earthquake in loess regions. The character of loess landsides, and the relationship between the loess landslide and earthquake are described.

(5) The problem of permanent displacement of ground surface in loess regions during strong earthquake is presented.

(6) The effect of ground fissures is discussed, too. The estimating methods about the effect of ground fissures on earthquake ground motion and earthquake damage is briefly expounded.

Finally an estimating example of a concrete loess site is introduced in order to explain the application of the above-mentioned methods.

LAKES AND PLAYAS: LOESS SOURCES OR SINKS?

J.M. Bowler, Chen Kezao, Zheng Honghan
and Yuan Baoyin

In aeolian systems involving deflation and deposition of suspended load materials those elements of the landscape that involve concentration of salts and water play a specially important role.

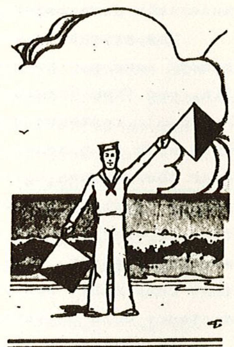
In dry regions of Australia and Qinghai Province China, salts help prepare sediment for transport. Terminal basins which concentrate salts become focal points for efflorescence, the growth of small salt crystals providing an effective mechanism for breaking down sediments and soils thus facilitating deflation. The importance of salt in the loess formation processes is reflected in the high levels of exchangeable chloride in the resulting deposits.

In Australia, especially during times of Pleistocene hydrologic change, saline playas contributed large volumes of aeolian clay to form both traction load dunes and suspended load sheet deposits (parna). In loess source areas of the Qaidam basin near Dulan, coppice and longitudinal dunes composed of coarse loessic materials form lateral equivalents of the Malan plateau deposits.

The extent to which lake basins act as traps for aeolian suspended load may be evaluated from evidence at Lake Frome, Australia, and from Qarhan Lake in Qaidam. Lake Frome (studied by Zheng Honghan) contains a clay mineral suite dominated by illite-kaolinite with some zones showing strong montmorillonite peaks. Moreover these zones correlate with major hydrologic changes. On a nearby Tertiary plateau surface, far above the level of alluviation, a clay blanket overlying gravels represents a suspended load aeolian deposit. This is dominated by montmorillonite suggesting that comparable zones within the lake represent equivalent long distance dust deposits.

In sediments of Qarhan salt lake, thick clastics have been deposited with halite throughout the past 25,000 years. The upper 45 metres contains about 45% clastics of which the major component is texturally and mineralogicaly identical to Malan loess. Moreover the total equivalent thickness(approx.20 metres)is consistent with this brine pool having been a trap throughout the period of Malan loess accumulation The contemporaneous deposition of halite and loess reflects the intensity of dry windy conditions in late glacial times.

Lakes retaining permanent water in the path of the dust trajectory have acted as dust traps accumulating sediment in transit. They are likely to provide excellent sequences to complement the stratigraphic sequence of the loess plateau. In this way, lakes and playas form a critical link in evaluating loess processes and history.



THE MAIN TYPES OF THE WATER EROSION AND ITS RELATED SOIL FACTORS IN THE LOESS PLATEAU OF CHINA

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Because there is very sparse vegetation in Loess Plateau,Land surface is usually bare and steep and the loess is extremely loose , splash erosion is very serious and causes the surface stagnant water muddy, the pores sealed, the soil permeability reduced, the runoff promoted and converged, the formation and development of the sheet and liniar erosion accelerated.

Sheet erosion occuring in the cultivated lands is mostly of loess parent material. Profile sheet erosion is only found on " Yuan", the top of "Liang"and "An" (saddle shaped land). It may be found on the sheep path distributed over the pasture slope is named as squamous erosion for it often appears squamous shape.

Liniar erosion can be mainly divided into rill, shallow gully and gully. Rill is often found on the cultivated slope lands and some gulch walls as well as hill tops and bare slopes where the bed-rock are exposed and strongly weathered. The area of rills may be sometimes more than 50% of the cultivated land and the eroded material may be about 50,000 $M^3/Km^2/yr$..

Shallow gully is a transitional form from rill to gully. It may be formed by the convergence of rills or developed directly from furrow. Gully is the most district sign of serious cutting and scouring by runoff on the land surface. Gully sometimes appears to hanging gully, blind gully, vertical hollow (dredged and sluiced by small water fall), sink hole , loess cave, tunnelling gully and loess bridge.

In the light of the specific contraction in the loess region, the runoff exceeding infiltration rate (supper infiltration) erosion is the main erodible form, the permeability of soil is the principal aspect of the contradition between the soil and flowing water. The soil permeability is dependent upon the soil texture, the soil structure and its stability, the soil pore space , soil profile constitution, the thickness of soil horizons, the soil moisture contents, etc..

As the soil resisting ability to erosion caused by water, we have classified this ability into anti-washability and anti-scourability. The former that refers to the soil dispersion and suspension is mainly dependent upon the affinity between the soil particles and water. The latter that refers to the soil ability to the mechanical disrupsion and pushing.

THE FIFTH PALEOSOL LAYER ON THE LOESS PLATEAU

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The fifth paleosol layer (S_5) with a larger thickness is well developed within Luochuan loess section. The age of fifth paleosol layer is about (460-560) 10^3 yr.B.P. by the known magnetic boundary ages with reference to the calculation of loess depositional rate. It is also clearly observed at different places on the loess plateau. The S_5 paleosol complex is composed of three paleosol layers and two thin loess layers intercalated with them. The pedogenic type of S_5 paleosol is similar to transitional type between recent brown and cinnamon soils, reflecting an optimum climatic event since the last 1 Ma ago. During the optimum recorded by S_5 paleosol, the mean annual temperature is about 12^o-14^o C and average annual precipitation is about 700-800 mm. at Luochuan location. The climatic event is of an universal significance in the whole loess plateau, and can be compared to a warm climate represented by the layer 10, which consists of human fossil (Homo erectus pekingensis)--bearing travertine and fine-grained deposits at Locality 1 of Choukoutien. Meanwhile, the optimum climatic event may be shown in the transgressive deposits on the coast areas of North China Plain and in a maximum interglacial paleosol on the Tibet Plateau as well as in different deposits from other areas during middle Pleistocene. Therefore, the event about 0.5 Ma ago was not only happened in the loess plateau, but also in the northern China. This is a significant sign for understanding the subdivision of Pleistocene strata and the climatic evolution in China.

The S_5 paleosol is tentatively correlated with oxygen isotopic stages 13, 14, 15 from deep sea core, that is a key to resolve the question of comparison between Luochuan loess sequence and oxygen isotopic records. In the stratigraphic section, bearing Lantian Man (Homo erectus Lantianensis), at Locality Chinjiawo near Xian, there exists a distinct S_5 paleosol within which three paleosol layers are more clear than that in Luochuan section. The further diagnosis and subdivision of S_5 paleosol complex from both Chinjiawo and Luochuan sections will be able to provide abundant informations of climatic oscillation during the optimum, and to have a correct comparison of individual paleosol or loess layer within S_5 with different oxygen isotopic stages respectively. However, authors still assume that such an important climatic event reflected by S_5 paleosol is also of a world wide significance.

PALEOGEOGRAPHICAL AND STRATIGRAPHICAL INFERENCE FROM THERMOLUMINESCENCE PROPERTIES OF SAALIAN AND WEICHSELIAN LOESSES: SOME PRELIMINARY RESULTS FROM NORTHWESTERN EUROPE.

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In this paper we report on a successful paleogeographical and stratigraphical investigation of northwestern European loesses using the thermoluminescence (TL) method.

The research, carried out at the laboratory of Mineralogy of the FAPOM (Mons), has been confined to the analysis of the detrital quartz fraction of pure aeolian saalian and weichselian loessic deposits, extending from North Belgium to Normandy (France). Our purpose is to bring into evidence spatial and stratigraphical variations of loess TL characteristics in order to contribute to the paleogeographica; reconstructions and stratigraphical correlations.

Investigation is made on samples taken from 16 reference loessic sequences under stratographical control.

The induced TL (ATL) method applied to the saalian loesses, (samples exposed to laboratory irradiation Co 60 source) , shows the existence of different types of detrital quartz assemblages within the investigated loessic area. Each quartz assemblage is characterized by a distinct ATL glow curve (resulting ATL output recorded as a function of T^o). The reproductibility of these curves within each deposit together with their regional homogeneity allow the definition of saalian loessic provinces as shown in figure 1.The inter-province heterogeneity of the loessic quartzose material over Northwestern Europe involves a diversity of their drift sources.

A comparative ATL study of saalian and weichselian loesses, reveals either a similitude or a difference in their quartz ATL behavior, reflecting either a constancy or a time change in their sediment provenance. This leads to definition of distinct weichselian loessic provinces as shown in figure 2. The time dependence of loess ATL characteristics provides thus a new stratigraphical tracer among loessic sediments. In regions where no change in sediment provenance can be traced by ATL alone, a concurrent use of natural TL (NTL) -(natural radiation dose)- successfully discriminates between saalian and wechselian loesses.

A heavy mineral analysis systematically complements our TL investigation. It generally confirms the above stated stratigraphical correlations.

These preliminary results obtained from quartzose components of loesses therefore provide a new promissing marker mineral for indentification and correlation of loessic deposits. Furthermore they enable us to specify the paleogeographical evolution of the northwestern European loessic area during the Saalian and the Weichselian. Additional investigation is required to indentify source area and sediment provenance of these loesses. The work is already underway at the Laboratory of Mineralogy of the FAPOM.

ON THE ENGINEERING GEOLOGICAL CHARACTERISTICS AND SOIL EROSION IN THE MIDDLE REACHES OF THE HUANGHE RIVER

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There is a centre of loess deposit of China in the Middle Reaches of the Huanghe River (Yellow River). The stratigraphic section of loess is very complete in this area. However, owing to loose texture, low degree of resisting erosion, readily running away with runoff, the loess has been seriously eroded. The degree of erosion of loess and its changing law is almost close with one's engineering geological characteristic except the factor of the geomorphological form of loess and climate, etc. On account of the differences of engineering geological characteristics among the new loess, old loess and fossil loess, their erosive properties exist also obvious differences. For example:

New loess. The new loess which has coarse grained clastics , many open grain, low content organic substance, higher content of bearing water soluble salt, a little of cement, poor consolidation and a lack of soil texture, rapidly disintegrates into a silt when it is immersed in the water. Because of the new loess that erect cracks and cavities are well developed is strong permeability, water-creep is formed under the moving hydraulic pressure. Therefore, the kind of loess to be seriously eroded has mainly been source of the sediment of the Huanghe River.

Old loess. Old loess which possesses multi-layers texture and contains a few layers of brown-reddish buried paleosol. According to the difference of the engineering geological characteristics of the strata, the old loess may be divided into the following two menbers:

Upper Old Loess, with the looser texture, well developing open grains, and soaking-setting lightly disintegrates into the silt when it is immersed in the water. It owns lower degree of the resisting erosion, so that soil is eroded more severely.

Lower Old Loess. It contains more clay particles and has a densed texture, poor in the large pores and no soaking settling . It disintegrates into a block or sheet-like loess when it is immersed in the water, Because of the higher degree of the resisting erosion, so the soil is not severely eroded.

Fossil Loess. With the thickness of 40 m, it is predominantly residual in the palaeodepression. The fossil loess of which rock property is uneven and hard, intercalates some paleosol layers. There exist the horizontal microstratifications and well developed micro-pores. No soaking-settling was found. Fossil loess mostly disintegrates into the block-like loess when it is immersed in the water. With a stronger degree of the resisting erosion, so it is eroded lightly.

In a word, although the loess erosion is controlled by external and internal geological agents dominating internal factor is still the engineering geological characteristics of loess.

THE DISTRIBUTION OF REE IN LOESS OF CHINA

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Rare earth elements (REE) in loess of China have been analysed by me ns of Instrumental neutron activation analysis (INAA) since 1979. The result indicates that the REE in loesses ranges in 150-210 ppm, with average of 176 ppm. Little variation in REE of different localities in the middle reaches of the Yellow River reflects the homogenity in composition of loessic materials. Rare earth elements in loess are mostly concentrated in detrital minerals in the silt-sized fractions.

The REE distribution patterns of loess in China are chiefly rich in LREE with negative slopes, showing slightly less europium depletion (Eu/Eu=0.71). The REE patterns are similar to one another in loesses of different localities and different period, indicating the consistency in their material sources. The fractionation among various ERRs in the loess is different from that in morainic,marine and lacustrine sediments, but is similar to that in sand samples from deserts of Northwestern China.

The REE patterns of loess in China are indistinguishable from that of loess in USSR (Tashkent), and are similar to those of average of North American Shales. This result happened to coincide with S.R. Taylors conclusion----the REE patterns for the widely scattered loess deposits (from America, China, Europe and New Zealand) are characterized by uniformity, and similar to those of average shales. Thus, it seems to be considered that the REE patterns of loesses represent the upper crustal average.

A STUDY ON MEDIUM ENVIRONMENT OF LOESS

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The hydrogen ion concentration (PH)and oxidation-reduction potential (Eh) are pricipal indicators of synthesizing characteristics reflected medium in physical and chemical properties of loess. The systematic determination of PH and Eh in loess in the middle reaches of the Yellow River has been done by means of pre cise acidometer. The results show that the medium environment of loess in this area is weak-alkalic or alkalic with mean PH 8.46, varying from 8.08 to 8.86, and of weak-oxidation with mean Eh 425 mV, rangine from 358mV to 469mV. The tendency of PH value variation descends, while Eh values raise from west to east in this region. Combining with factors of $CaCO_3$, ferric ion, ferrous ion and organic contents we find that the PH and Eh values are

affected by $CaCO_3$, ferric and ferrous ion contents. In face,with increasing of the $CaCO_3$ contents the PH value increases and Eh decreases. The ratio of Fe^{+3}/Fe^{+2} is positive correlation with Eh values and negative correlation with PH values. The organic contents are usually low in loess. So it does not affect PH and Eh in considerable amounts.

The comparision of PH and Eh in different strata of loess has also been made in present study. The following order from low to high in PH value in Luochuan section has been found; paleosol, berried weathering strata and loess, whereas, the Eh value varies reversely. These results suggest that the PH and Eh magnitudes in different strata reflect palwoclimate fluctuation during loess sedimentation.

GULLY CHANGES IN THE LOESS PLATEAU OF CHINA DURING THE HISTORICAL PERIOD

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There are a great number of gullies in the Loess Plateau of China before the historical period. Afterwards in the historical period, the gullies have gone on forming and developing, whose processes are more intensive than ones before historical period to some extent. It is the main cause for the formation and development of gullies that the loess is loose and easy to erode . Besides natural factors, the artificial ones are important to form gullies in historical period. For example, the increasing of loess erosion caused by vegetation ruin is one of the reasons .Up to now, Loess Plateau appears to be in criss-cross forms, which are not only the influence of local production but also the save of river channel of the lower reaches of the Yellow River.

The formation and change of the gullies have experienced certain process. The formation and change process of the gullies in historical period may be calculated .If the historic sites with absolute or relative age near the gullies have been found, this calculation can be done. On the basis of the absolute or relative age data, the monuments from the former cities, the imperial palaces, the ancient passes and the Great Wall existing may be calculated, the developing processes of the gullies, because of the length of upward extention of the gullies through these monuments with ages, can be determinated. According to the calculation results, the characteristics of gullies development can be gained.

ON THE FORMATION AND THE DEVELOPMENT OF THE STRUCTURE OF COLLAPSING LOESS IN CHINA

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It is well known that the regional variations in microstructure of loess are consistent with the changing tendency of collapsibility towards gradually decreasing from the northwest to the southeast and with variations in climatic condition. It indicates that the microstructure of collapsing loess is closely related to the climatic condition and geological environment.

Based on the microstructure analyses, it can be considered that the formaion and development of the structure of collapsing loess in China has undergone five stages: the loessization stage , the formation stage, the development stage, the ageing stage and the clayization stage. The five stages of loess formation are respectively shown in defferent regions of the Loess Plateau.

This also indicates the collapsing loess in the northwest of the Loess Plateau is still developing under modern climatic conditions. Whereas, the collapsing feature of loess is gradually disappearing in the southeast of Loess Plateau in China.

THE INVESTIGATION ON HYDROGEOLOGY AND ENGINEERING GEOLOGY OF LOESS IN CHINA

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The main aim of the investigation on hydrogeology and engineering geology in the loess area is to solve the problems for the exploitation of ground water, the stability of ground and slope in the industrial as well as civil architectural projects and in construction of communications, and the soil erosion.

In respect of hydrogeological research, of late years, it is emphatically to investigate the regularity about the movement of water in unsaturated zone of great thick loess layers, the formation of gravitational water and the characters of porous- fissure medium behavior of loess as to direct the way to exploit the

phreatic water in loess. In respect of engineering geology,in recent years, a profound understanding on the relationship between micro-fabric and the wet-collapsibility of loess has been expounded. The research on regional engineering conditions and their effects on seepage of slope and canal in loess area has substantial contents, and a great amount of experiences in practice have been accumulated.

In the serious soil-erosion area of the loess plateau, quantitative study on soil erosion has been conducted by the method of taking airphoto on the large scale, investigating the developing rate of erosion and the quantity of sediment yield and determining the intensity of the erosion process.

THERMOLUMINESCENCE DATING OF LOESS SECTIONS-A RE-APPRAISAL

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During the last six years, many laboratories round the world have started to apply the thermoluminescence (TL) dating method to their Quaternary sediments. The method has been shown to be particularly suited to aeolian sediments such as loess.

The basis of the method is the ability of minerals, such as quartz and feldspars, to trap electrons produced by radioactive decay processes in the natural environment. These electrons are removed from their traps when the grains are exposed to light, as in aeolian transport. Thus the number of electrons in the minerals today represents the amount of time that has passed since the grains were last exposed to light, i.e. deposition. Heating the grains in the laboratory also releases the electrons which then recombine within the crystals and produce light. This is the natural TL signal which is compared with the TL produced by laboratory irradiation. This comparison yields the equivalent dose (ED) used in the age equation.

There are many differences in the methodology used in different laboratories. These can give rise to substantial differences in the ages obtained. In this paper I will present the advantages and disadvantages of the different methods, with particular reference to

a) mineral type - quartz and feldspars
b) grain size
c) bleaching and irradiation procedures
d) annual dose rate determinations.

Results of TL investigations on loess sections from northweatern Europe will be presented.

STUDIES IN GEOGRAPHY IN HUNGARY

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LOESS AND THE QUATERNARY:
CHINESE AND HUNGARIAN CASE STUDIES

Edited by MÁRTON PÉCSI

The majority of the present papers were delivered as lectures at a seminar organized by INQUA Hungarian National Committee in Budapest, October 1984. In the volume comprehensive information is presented on loess in China and in Hungary as well as on the state of Quaternary research. Results achieved in several earth science fields of the stratigraphy, geomorphology, paleontology, pedology and geochemistry are summarized in a form which promotes their application in the related sciences too and serves to broaden the horizon of geologists and other experts in geosciences. The Chinese party presented papers on the geochemical properties of loess in China and the stratigraphic interpretation of paleomagnetic data. The Hungarian contributions are concerned with lithology, paleontology, biostratigraphy and dating of Quaternary sediments and the mineralogical composition, geochemical properties, classification and genesis of loess as well as the analysis of soils formed on loess. The parallel papers allow certain correlations between loesses in China and Hungary.

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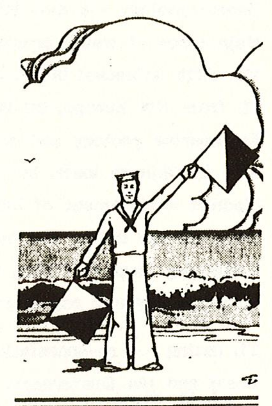

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