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The Late Pleistocene Loess Stratigraphy of the Bačka and Srem Region (Vojvodina, Serbia) – Old Results in the Light of New Ones

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Serbien
Pleistozän
Löss
Paläoboden

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Die spätpleistozäne Löss-Stratigraphie des Bačka- und Srem-Gebietes (Vojvodina, Serbien) – Alte Ergebnisse in neuem Licht

Zusammenfassung

Die spätpleistozäne Löss-Stratigraphie des Bačka- und Srem-Gebietes beschäftigte in vergangenen Jahrhundert zahlreiche Geowissenschaftler. Die ersten Forschungsresultate basierten auf Beschreibungen von Löss-Paläoboden-Abfolgen und ihrer Korrelation mit anderen Lokalitäten des Donauraumes. PÉCSI und BRONGER begannen mit Studien zur mineralogischen, mikromorphologischen und pedologischen Entwicklung der Paläoböden. Basierend auf Lumineszenz-Datierung schlagen SINGHVI und sein Team eine Revision der früheren Resultate vor, da die Untersuchungen für Tschernoseme und tschernosemähnliche Böden ein höheres (interglaziales) Alter zeigen. Im letzten Jahrzehnt bewies MARKOVIĆ mit seinem internationalen Team durch multidisziplinäre Forschung an Löss-Paläoboden-Sequenzen das MIS-5-Alter des Tschernosem-Pedokomplexes. Nach jüngsten Entwicklungen und mit umfangreichem Datenmaterial wird die lössstratigraphische Nomenklatur der pleistozänen Formationen an die chinesische Löss-Stratigraphie angepasst und mit den marinen Sauerstoffisotopen-Stufen korreliert.

Abstract

Late Pleistocene loess stratigraphy of the region of Bačka and Srem attracted numerous geoscientists in the past century. The first results of investigations were mainly based on descriptions of loess-paleosol sequences and their correlation with other sites in the Danube Valley of Central Europe. Pécsi and Bronger's studies were the first to be based on mineralogy, micromorphology and soil development of paleosols. Later with the development of luminescence dating techniques SINGHVI and his team suggest the revision of previous results, because the results show that the chernozem and chernozem-like soils are older (interglacial age). In the last decade after international investigations lead by MARKOVIĆ and his group, the multidisciplinary research of loess-paleosol sequences proves the MIS 5 age of the developed chernozem pedocomplex. According to the recent developments and the derived data the regional loess stratigraphical nomenclature of Pleistocene formations is changed and adapted to the Chinese loess stratigraphy and clearly correlated with the marine oxygen isotope stages.

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1. Introduction

In the Middle Danubian Basin loess and loess-like deposits cover various morphotectonic levels over a total area of ca. 150,000 km^2. Basin types of various elevation and size are predominant. Under different geomorphological and morphotectonic conditions over an identical time interval the variation in the rate of basin subsidence produces various litho and chronostratigraphical sequences (PÉCSI & RICHTER, 1996).

The investigated area is located in the southeastern part of the Carpathian Basin, in the region of Bačka and Srem (Vojvodina, Serbia). This work concerns only the loess-paleosol sequences which are deposited in the mentioned area of western part of Vojvodina. The analyzed Late Pleistocene loess-paleosol sequences were formed under similar sedimentary conditions and sedimentation patterns in the Pannonian lowland.

One of the long debated topics in the past were the time span of loess formation and the age of loess-paleosol layers in Serbia (e.g. ZEREMSKI, 2007). During the past two decades new principles, more sophisticated methodology and research techniques of great importance were introduced, particularly in loess chronostratigraphy and in the analysis of its physical and chemical properties. The magnetic susceptibility analysis and more sophisticated radiometric dating techniques (e.g. OSL) of the loess-paleosol sequences seem to be some of the new methods in loess stratigraphy.

Thanks to good preservation, only the open profiles in Neštin and Zemun are not available to investigations, but fortunately there still exist open profiles close to them of same or similar sedimentary pattens.

After the results of the studies of the International Union of Geological Sciences and UNESCO – International Geological Correlation Programme (IGCP) – Project 24 "Quaternary glaciations in the northern hemisphere" the "classical views and theories" on Quaternary glacial stratigraphy prevail (ŠIBRAVA et al., 1986) and the proposed stratigraphy based on Marine oxygen isotope stages (MIS) was adopted for the loess-paleosol sequences of Vojvodina.

2. From the Lithological Descriptions to PÉCSI's Stratigraphical Divison of Loess-Paleosol Sequences

The loess-paleosol sequences of the Stari Slankamen section were among the first in the Srem region to have a scientific lithological description. It was carried out by the Croatian geoscientist GORIJANOVIĆ-KRAMBERGER (1912). For the description of the open profile by the road between Novi Slankamen and Stari Slankamen GORIJANOVIĆ-KRAMBERGER used the letter "L" for loess units and "V" for "clayely horizons" (paleosol layers). The numbering of the same lithological units starts from the lowermost (older) parts and continues with increasing numbers to the upper (younger) layers (Table 1/④). After nearly a decade of geological and geomorphological investigations in the interfluve's area of Danube and Sava rivers (Srem region) GORIJANOVIĆ-KRAMBERGER (1920) recognized at the same profile some pedofeatures of paleosols ("brown zones" as described in his paper) and used a new nomenclatural prefix "S" for paleosol layers (Table 1/③).

In comprehensive studies of Quaternary formations in the territory of the Carpathian Basin, PÉCSI (1966) mentioned that the last interglacial soils cannot be chernozem or chernozem-like paleosols. His statement was that the chernozem and chernozem-like soils could only be interstadial soils (while the interglacial soils should be more "brownized" – converted to the brown forest soils). This shows in the stratigraphical division, thus in the paper of PÉCSI (1966) the boundary between the Late and Middle Pleistocene has been put on a lower position than the loess-paleosol sequences of Vojvodina (investigated sections: Stari Slankamen, Titel and Mošorin). This cannot be confirmed for the area of Hungary, but it seems, a similar problem exists caused by the chronostratigraphic subdivision established by PÉCSI (1966), e.g. SINGHVI et al. (1989), SÜMEGI & KROLOPP (2005).

The pedostratigraphical nomenclature of PÉCSI's studies (PÉCSI, 1966) used the prefix "F", indicating the first letter from the Hungarian word "föld" (soil). The numbering of the layers started from the upper (younger) and countinued to the lower (older) strata. According to the situation on the field and realized studies for loess-paleosol sequences of the Bačka and Srem region, the "F1" layer corresponds to the MIS 3, "MF" (Mende felső) and "F2" layers correspond to the MIS 5 pedocomplex (Table. 1/④).

The studies of MARKOVIĆ-MARIJANOVIĆ (1972) for the symposia of INQUA's Subcommission of Loess Stratigraphy on the loess sections along the Serbian part of the Danube Valley have been presented. In her investigations, the profiles of Smederevo, Belgrade-Banovo Brdo, Zemun, Batajnica, Stari Slankamen and Neštin have been described, which were correlated according to their position and (paleo)pedological features with the main sections of Austria and former Czechoslovakia (Table 1/③).

The loess stratigraphy of Bohemia, Moravia and Central Europe was established by KUKLA and LOŽEK (e.g. KUKLA, 1961; KUKLA & LOŽEK, 1961) by using glacial cycles and is still commonly used in interpreting some stratigraphical results (e.g. amino acid geochronology of Central Europe) (Table 1/③).

BRONGER (1976) in his investigations mainly based on paleosol micromorphology and clay mineralogy, concerning pedostratigraphy of the Carpathian Basin, also investigated loess sections of the Bačka and Srem region (Stari Slankamen, Neštin, Mošorin-Dukatar, Titel, Sivac and Kula). In his work the influences of PÉCSI (1966) are evident. The last interglacial paleosol „F2" was correlated as Würmian soil. In the case of the sections Kula and Sivac, sites which are located at the southernmost part of the Telečka/Telecska Loess Plateau, the pedocomplex which represents the last interglacial and the beginning of the last glacial unit (MIS 5) just named with "S" and they were not correlated with the other sections of the Carpathian Basin (Table 1/② and ③).

3. Advanced Techniques Suggest the Revision of Late Pleistocene Loess Stratigraphy in the Bačka and Srem Region

The paper presents the results of thermoluminescence dating of the Carpathian Basin realized by SINGHVI et al. (1989). They suggested the revision of the conventional chronology; according to their results they stated that some units should be much older than they are presented in previous studies (Table 1/②). SINGHVI et al. (1989) recognize that the layers of well developed chernozem paleosol ("F2" and "F3") cannot be interstadial soils. They were first described as interglacial paleosols. According to the TL data the "F2" strata are correlated with MIS substage 5a, but the authors insist on the revision of previous works.

BRONGER (2003) in his work of correlating the East European and Central Asian loess-paleosol sequences described the last interglacial paleosol pedocomplex as the MIS 5a subunit, which according to his viewpoint is equal to the "MF2" subunit (Table 1/① and ②).

Table 1.
Late Pleistocene correlation tables of loess-paleosol sequences in the Bačka and Srem region with correlation of the global marine oxygene isotope (MIS) record (GIBBARD et al., 2004) and the regional stratigraphical division suggested by MARKOVIĆ et al. (2008).

	MIS	Marković *et al.*, 2007	Markovic *et al.*, 2006	Markovic *et al.*, 2005, 2004	Bronger. 2003 (Pécsi, 1966)
①	2	V L1 L1	SL L1 LL1	L1L1	
	3	V L1 S1	SL L1 SS1	L1S1	
	4	V L1 L2	SL L1 LL2	L1L2	
	5	V S1	SL S1	S1	MF2

	MIS	Marković *et al.*, 2007	Bronger 2003, Singhvi *et al.*, 1989 MIS	Bronger 1976, 2003, Singhvi *et al.*, 1989	Bronger 1976, 2003, Singhvi *et al.*, 1989
②	2	V L1 L1			
	3	V L1 S1			F1
	4	V L1 L2			
	5	V S1	5a	S	F2

	MIS	Marković *et al.*, 2007	Bronger, 1976 Alpine stratigraphy	Kukla, 1961	Markovic - Marijanovic, 1972 Fink, 1954	Kukla & Ložek, 1961
③	2	V L1 L1		Cycle B		
	3	V L1 S1			Stillfried B	PK I
	4	V L1 L2				
	5	V S1	Würmian soils		Stillfried A soils	PK II

	MIS	Marković *et al.*, 2007	Pécsi, 1966		Pécsi, 1966 Alpine stratigraphy		Gorijanovic-Kramberger, 1920	Gorijanovic-Kramberger, 1912
④	2	V L1 L1			Upper Würmian	Upper Würmian	L5	L5
	3	V L1 S1	F1					
	4	V L1 L2				Middle Würmian		
	5	V S1	F2	MF	Middle Würmian		S4	V4

4. Multidisciplinary Research and the New Results in Late Pleistocene Loess Stratigraphy and New Lithological Nomenclature

In order to use a uniform chronostratigraphical and lithological pattern in a precise and clear description of the units of loess-paleosol sequences, the proposed stratigraphical division for the Late Pleistocene in Vojvodina has been realized by MARKOVIĆ et al. (2007) after absolute numeric age datings (e.g. BOKHORST et al., 2006a, 2006b), magnetic susceptibility measurements of numerous sections in the investigated area (MARKOVIĆ et al., 2008), correlation to the marine oxygen isotope record and adaptation to the development of loess-paleosol sequences in the region.

The division is based on the nomenclature of Chinese loess deposits (e.g. GIBBARD et al., 2004; MARKOVIĆ et al., 2004, 2005) (Table 1/①); the prefix "V" corresponds to the loess-paleosol sequences of the Vojvodina region. The previously used "SL" prefix which pointed to the loess section at the Stari Slankamen site (MARKOVIĆ et al., 2006), due to an incomplete Middle Pleistocene record, and fortunately with archives in the neighbouring area (Titel Loess Plateau and Batajnica section) could create a detailed complete synthetic record of Middle and Late Pleistocene. Thus the prefix "SL" has changed to "V" – associated with the regional name of the Vojvodina area (Table 1).

In order to understand the references of different authors, and the correlation of loess-paleosol sequences of marine oxygen isotope record (MIS) as the newly established regional chronostratigraphical model for the region of Vojdodina, based on Chinese loess stratigraphy, the correlation table(s) are created to simplify the developments in loess stratigraphy of the analyzed region (Table 1).

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