ABHANDLUNGEN DER GEOLOGISCHEN BUNDESANSTALT
Abh. Geol. B.-A. | ISSN 0378-0864 | ISBN 978-3-85316-043-5 | Band 62 | S. 131–137 | Wien, August 2008
Veränderter Lebensraum – gestern, heute und morgen
Hauptversammlung der Deutschen Quartärvereinigung e.V. (DEUQUA) in Wien: 31. August – 6. September 2008

Pedostratigraphical Correlation of Brunhes Age Loess-Paleosol Sequences in East and Central Asia with Central Europe

ARNT BRONGER*)

3 Text-Figures

Loess
Paläoboden
Pedostratigraphie

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Pedostratigraphische Korrelation von Brunhes-zeitlichen Löss-Paläoboden-Sequenzen von Ost- und Zentralasien mit Mitteleuropa

Zusammenfassung

Die Abfolge von Lössen und Paläoböden von Karamaydan (Tadschikistan) sollte als Referenzprofil für die Rekonstruktion der Klimageschichte des temperierten Klimagürtels der Nordhemisphäre während der Brunhes-Epoche betrachtet werden. Diese Schlussfolgerung wird durch die Korrelation mit der $\delta^{18}O$-Tiefseekurve gestützt. Eine chronostratigraphische Korrelation der Löss-Paläoboden Sequenzen des Karparten-Beckens und der zusammengesetzten Abfolge in Tschechien mit den Referenzabfolgen von Karamaydan und Luochuan (China) wird vorgestellt.

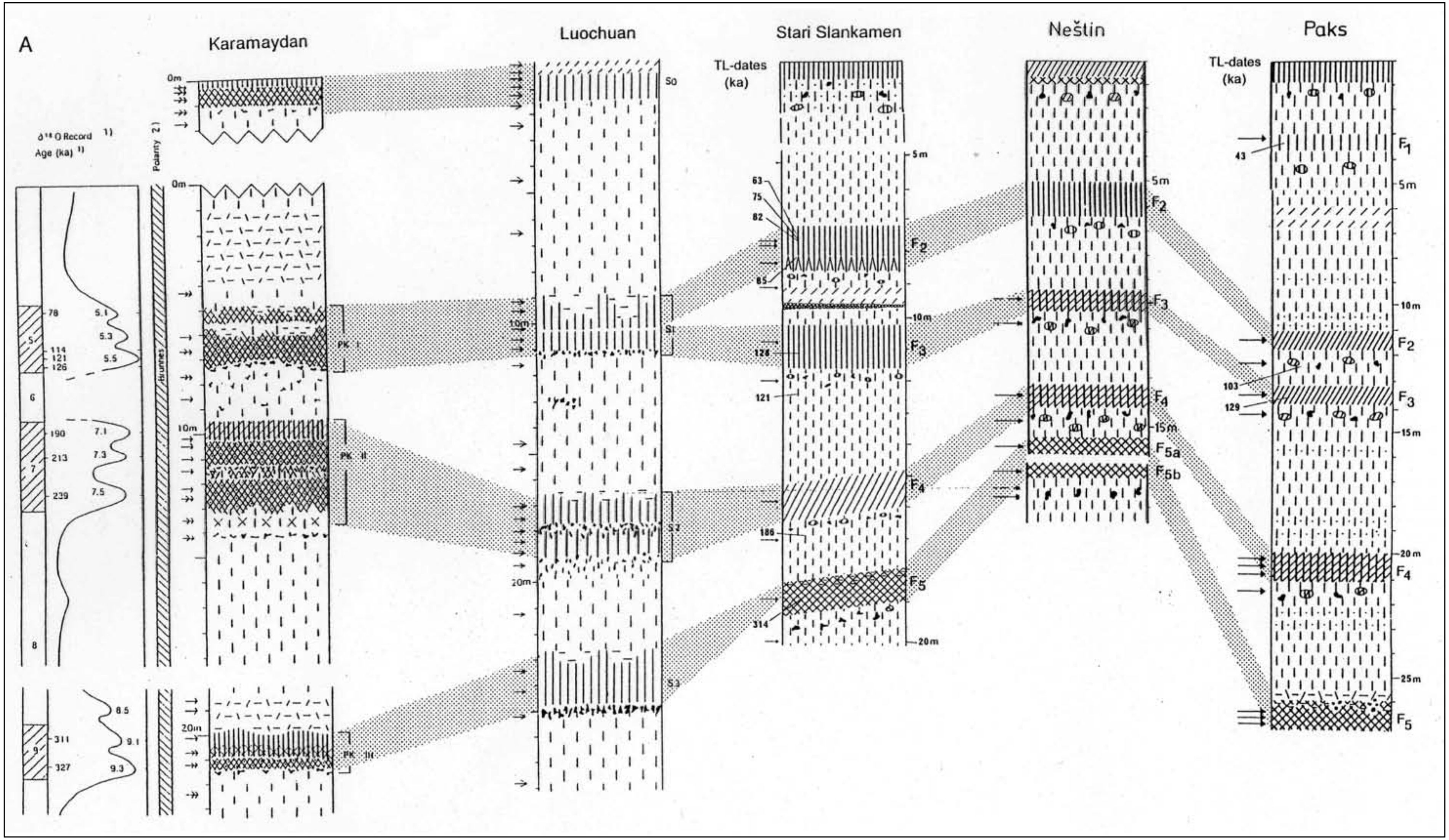
Abstract

The loess-paleosol sequence in Karamaydan (Tadjikistan) should be regarded as a key sequence in the temperate climatic belt of the Northern Hemisphere for reconstructing the climatic history of the Brunhes epoch. This conclusion is supported by a correlation with the deep-sea oxygen isotope record. A chronostratigraphical correlation of the loess-paleosol sequences of the Carpathian Basin and the composite section in Czechia with the key sequences of Karamaydan and of Luochuan (China) is proposed.

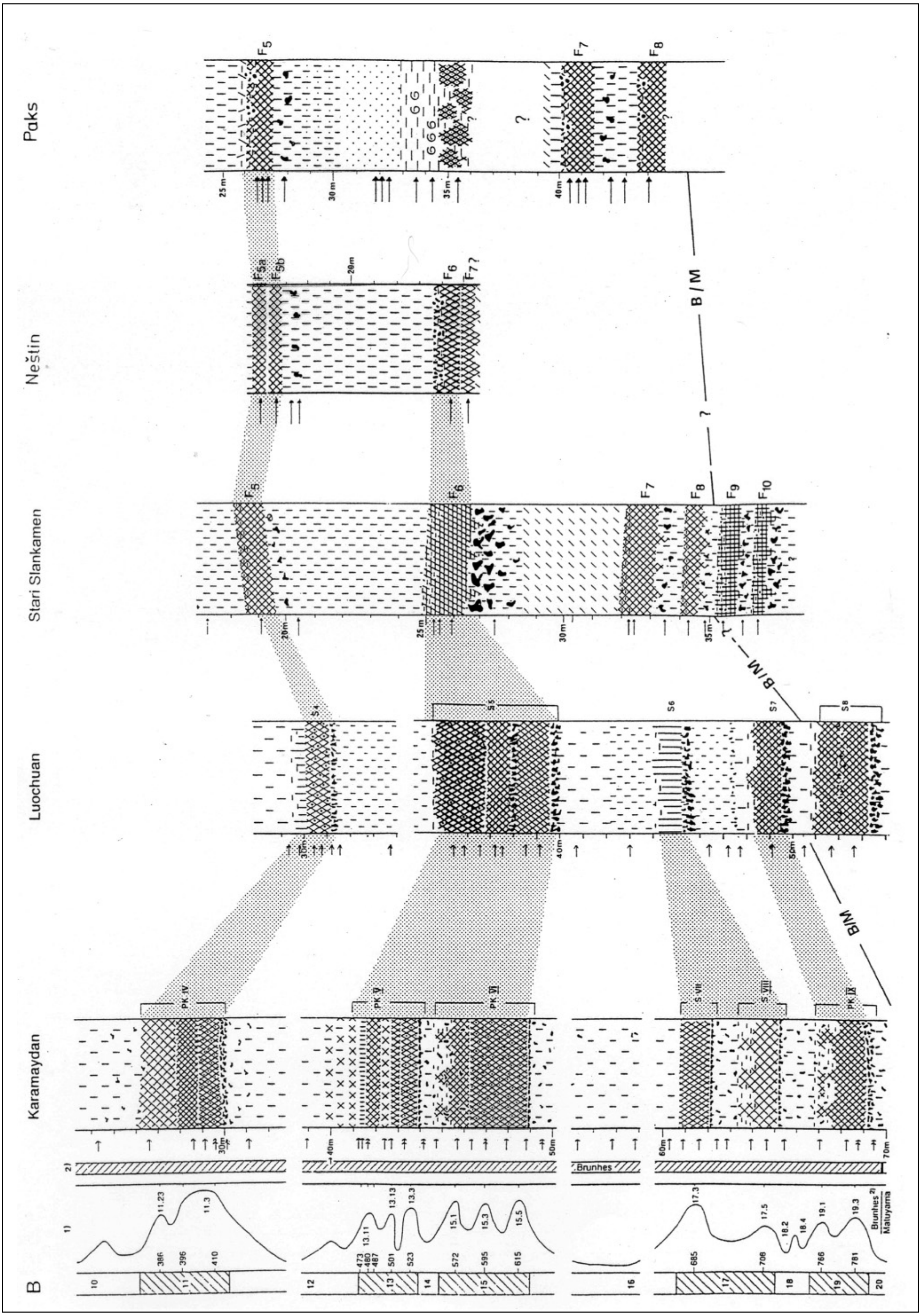
1. Introduction and Approach

Recent small climatic fluctuations on a 10^2–10^3 year time scale can be correlated at least throughout the temperate climatic belt of the Northern Hemisphere, for example by distinct moraines dated to about 1850 AD in similar positions above the present day glaciers in the southeastern Canadian Rockies, the European Alps and in the Tian-Shan near Urumqi, China. These moraines result from glacier advances caused by a decline of mean annual temperature of only about 0.4–0.8°C until 1950 for the Alps (MAISCH, 1995, p. 687). This suggests that major climatic changes on at least a 10^5 year scale (glacial/interglacial cycles) and in all probability a 10^4 year scale (the approximate length of an interglacial), must be of similar ages throughout the temperate climatic belt of the Northern Hemisphere.

*) ARNT BRONGER, Universität Kiel, Geographisches Institut, D 24098 Kiel.



Text-Fig. 1.
Genesis of paleosols and pedostratigraphic correlation between the sections of Karamaydan/Tadjikistan, Luochuan/China, Stari Slankamen and Neštin/Yugoslavia and Paks/Hungary.
A = PK I – PK III Karamaydan with S1–S3 (Luochan) and F2–F5a (East Central Europe); B = PK IV – PK IX (Karamaydan) with S4–S7 (Luochan) and F5bñF8 (Southeast Central Europe).
Legend see Text-Fig. 3.

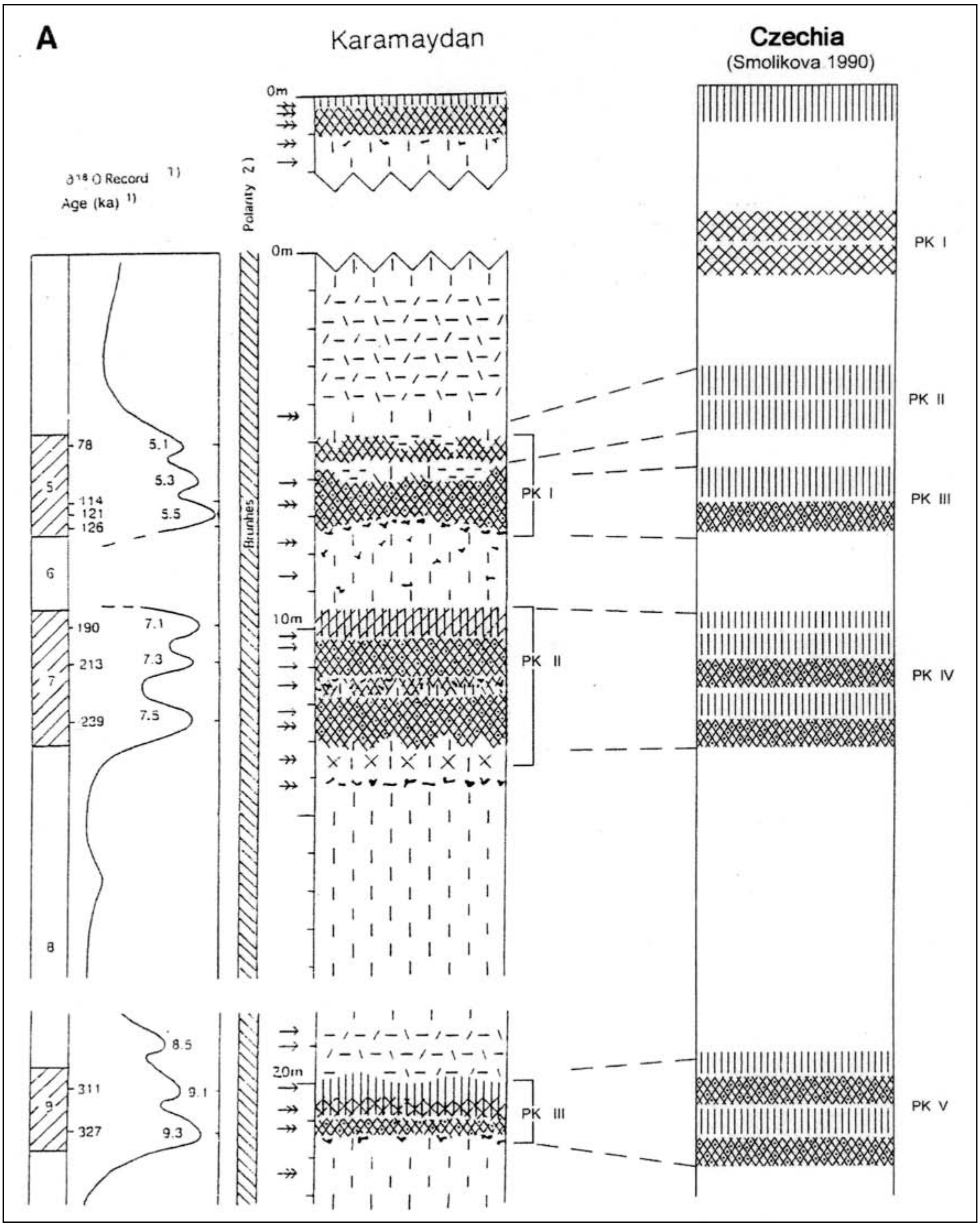

B
Karamaydan
Luochuan
Stari Slankamen
Neštin
Paks
PK IV
PK V
PK VI
S VII
S VIII
PK IX
S4
S5
S6
S7
S8
F5
F5a
F5b
F6
F7
F7?
F8
F9
F10
B/M
Brunhes
Brunhes
Matuyama

This concept is important for continental pedostratigraphical correlations, especially in loess-paleosol sequences for the Brunhes epoch that correspond with time-equivalent parts of the deep-sea oxygen isotope record dated by an accurate astronomical time scale of BASSINOT et al. (1994). Even at a substage level, we are now close to a chronostratigraphical correlation between loess-paleosol sequences in different continents of the Northern Hemisphere. This means that gaps in the sequences can be identified.

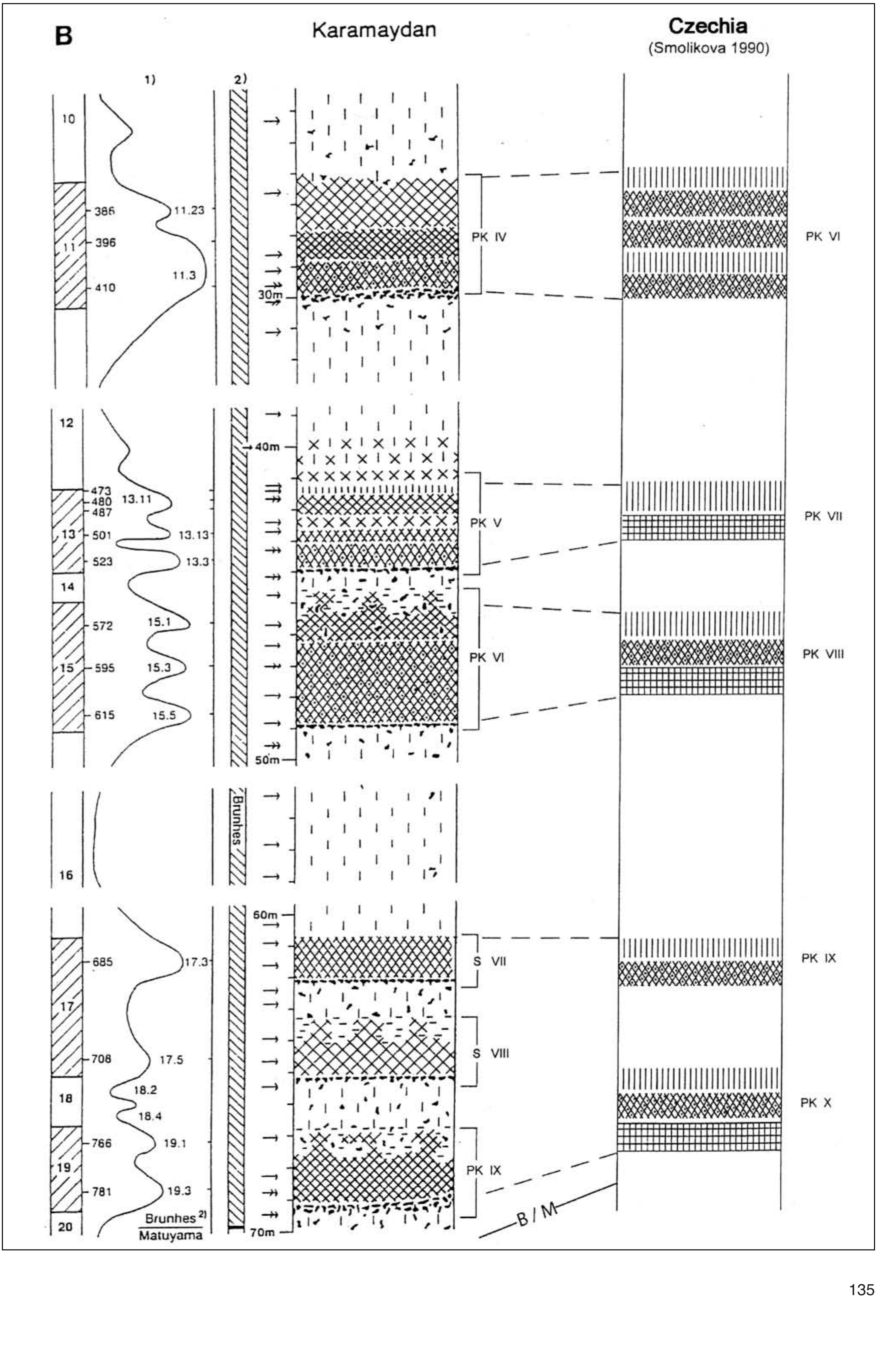
Detailed knowledge of the genesis of paleosols is needed to establish loess-paleosol stratigraphies that can be used for paleoclimatic reconstruction. Most paleosols, however, are truncated and largely recalcified from overlying loess. Micromorphological studies allow primary and secondary carbonates to be distinguished and provide unequivocal evidence of clay illuviation. This enables the recognition of typical loess, weathered loess and the recognition of different genetic soil horizons, such as CB (still with primary carbonates), BC, Ah, Bw, B and Bt horizons (see legend of Text-Figs. 1 and 2).

2. Karamaydan/Tadjikistan – a Key Sequence for the Brunhes Epoch

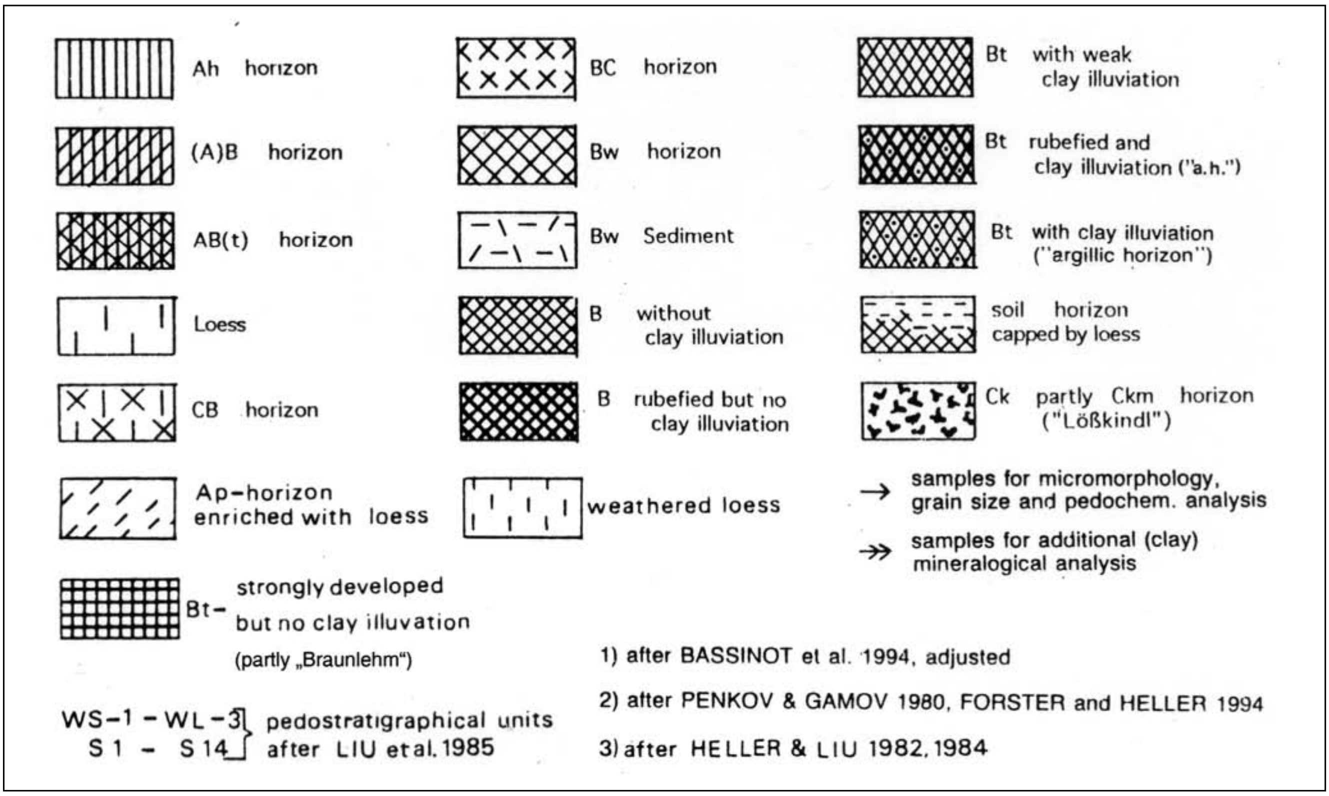
The pedostratigraphical correlation of the loess-paleosol sequences in Karamaydan and Luochuan for the Brunhes epoch is based mainly on two control points. First, the Brunhes/Matuyama (B/M) boundary of about 780 ka (probably 800 ka, see below) was found in both profiles (PENKOV & GAMOV, 1980; HELLER & LIU, 1984; FORSTER & HELLER,



Text-Fig. 2.
Genesis of paleosols and pedostratigraphic correlation between the sections of Karamaydan (Tadjikistan) and the composite section of Czechia in the Brunhes chron.
A) PK I – PK III Karamaydan with PK II – PK V (Czechia).
B) PK IV – PK IX (Karamaydan) with PK VI – PK X (Czechia).
Legend see Text-Fig. 3.



B
Karamaydan
Czechia
(Smolikova 1990)
1)
2)
10
11
386
396
410
11.23
11.3
30m
PK IV
PK VI
12
13
14
15
473
480
487
501
523
572
595
615
13.11
13.13
13.3
15.1
15.3
15.5
40m
50m
PK V
PK VI
PK VII
PK VIII
16
Brunhes
60m
17
18
19
20
685
708
766
781
17.3
17.5
18.2
18.4
19.1
19.3
S VII
S VIII
PK IX
PK IX
PK X
B / M
Brunhes 2)
Matuyama
70m



Text-Fig. 3.
Legend for Text-Figs. 1 and 2.

1994). Second, the lower soil of the pedocomplex S1 at Luochuan and the lower soil of PK I at Karamaydan both represent the last interglacial or stage 5.5 in the oxygen isotope record (Text-Fig. 1A). This is supported by TL ages around 110 ka for the lower soil and 85 ka for the upper soil of the S1 pedocomplex at Luochuan (NISHIMURA et al., 1984; LIU, 1985, pp. 213–237; WINTLE, 1987). Similar luminescence dates were reported from the PK I in the Chashmanigar area by FRECHEN & DODONOV (1998).

A comparison of the loess-paleosol sequences at Karamaydan and Luochuan for the Brunhes epoch (BRONGER et al., 1998a) clearly indicates that the sequence in Karamaydan is the more detailed one (Text-Fig. 1A, B). To summarize, the loess-paleosol sequence in Karamaydan should be regarded as a key sequence in the temperate climatic belt of the Northern Hemisphere for reconstructing the climatic history of the Brunhes epoch. This conclusion is supported by a correlation with the detailed deep-sea oxygen isotope record of BASSINOT et al. (1994), tuned to an accurate astronomical time scale. It allows a detailed chronostratigraphical correlation with the loess-paleosol sequence of the key profile at Karamaydan for the Brunhes chron down to the substage level (Text-Figs. 1, 2). However, the B/M boundary shown by Bassinot et al. is in the lower part of stage 19, whereas in exposures in Tadjikistan and the Chinese Loess Plateau it is usually found in the loess between PKs IX and X or between S7 and S8 (SHACKLETON et al., 1995), a level which is probably equivalent to oxygen isotope stage 20. An explanation based on a possible delay in magnetization is discussed by VAN DER VOO (1999, p. 279).

3. Pedostratigraphical Correlation with Loess-Paleosol Sequences in Central Europe

A chronostratigraphical correlation of the loess-paleosol sequences of the Carpathian Basin especially of Stari Slankamen and Nestin (Serbia) and Paks (Hungary) with the key sequence of Karamaydan and the key sequence in Luochuan is shown in Text-Fig. 1A and B. It is based on the two control points mentioned already. The Brunhes/Matuyama boundary, however, was found only at Dunaföldvar north of Paks (PECSI & RICHTER, 1996, p. 222) and in Paks itself below the F8 paleosol (PECSI & PEVZNER, 1974; MARTON, 1979), which is probably pedostratigraphically equivalent to the F8 in Stari Slankamen (BRONGER, 1976). The second control point is the F3 paleosol which represents the Riss/Würm interglacial (SINGHVI et al., 1989) or stage 5.5 in the oxygen isotope record (Text-Fig. 1A).

The conclusion that the sequence in Karamaydan should be regarded as a key sequence for the Brunhes epoch implies that the loess-paleosol sequences in the Carpathian Basin (Text-Figs. 1A, B) are less complete than thought earlier (BRONGER, 1976; BRONGER & HEINKELE, 1989). As an example, the very strongly developed F6 paleosol with a distinct Ck (partly Ckm) horizon is well preserved only at Stari Slankamen but also occurs at Nestin. Its mineralogy and genesis as a welded paleosol is explained by BRONGER et al. (1998b). Earlier the F6 soil was correlated with the three soils of the S5 pedocomplex at Luochuan (BRONGER & HEINKELE, 1989), and therefore with the two pedocomplexes PK VI and PK V at Karamaydan (BRONGER et al., 1998 a). PK VI at Karamaydan probably contains three paleosols because the lowermost Bt horizon is too thick for a single or monogenetic Bt horizon. It can probably be correlated with δ^{18}O-substages 15.5, 15.3, and 15.1 (Text-Fig. 1B). PK VI and PK V were formed over a period of about 140 ka according to the correlation with the oxygen isotope record of BASSINOT et al. (1994), although pedogenesis was interrupted several times by loess deposition.

The correlation of the pedocomplexes in Karamaydan with the pedocomplexes of the composite section in Czechia (SMOLIKOVA, 1990) in comparison with the single profiles in the Carpathian Basin is easy (Text-Fig. 2A, B). The control points of the correlation are the Brunhes/Matuyama boundary found below the PK X in Czechia

(ZEMAN, 1992) and the PK I in Karamaydan corresponding with the lower soil of the PK III in Czechia, equivalent to stage 5.5 in the OIS. The pedostratigraphical correlation allows an exact time frame of the formation of each pedocomplex in Czechia in the Brunhes chron. So for instance, the PK VIII in Czechia correlated with PK VI in Karamaydan (Text-Fig. 2B) was formed in the $\delta^{18}O$ stages 15.5 to 15.1 between 615 and 570 ka. The PK IV in Czechia, correlated with PK II in Karamaydan (Text-Fig. 2A) was formed in the $\delta^{18}O$ stages 7.5 to 7.1 between 240 and 190 ka.

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Manuskript bei der Schriftleitung eingelangt am 2. Juli 2008