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Field Trip Guidebook

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Foreword

Dobrogea County represents a large area bordered by the Danube, the Danube Delta and the Black Sea, consisting of three main tectonic units separated by important fault lines. Dobrogea is characterized by a complex geological structure, including old orogenic belts and platforms and containing formations from Neoproterozoic to Holocene. The common feature of the three units of Dobrogea is the vast Quaternary cover, starting with Lower Pleistocene reddish clays and continuing up to Holocene with a sequence of various thicknesses (2-20 m) enclosing up to 6 couples of loess-paleosoil layers.

At the northern border of Dobrogea is situated the Danube Delta, the second largest delta in Europe (4152 km^2). This Quaternary edifice consists of a thick accumulation (up to 400 m) of detritic deposits formed mainly during the upper Pleistocene and Holocene. The deltaic conditions occurred when the Danube started flowing into the Black Sea basin.

The eastern border of Dobrogea is the Black Sea. Numerous oceanographic expeditions provided data on the complex structure of the Quaternary deposits and the correlation of these with land events. A complicated system of paleochannels and their connections with the old course of Danube have been evidenced.

As shown, Dobrogea and its neighborhoods represent a good laboratory for Quaternary studies, and, we hope, it will be a good place for our meeting. We welcome the participants and we wish them to have a profitable and valuable opportunity for scientific contributions and debates concerning various aspects of Quaternary research.

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ANNEXES

1. OVERVIEW OF THE LOESS ACCUMULATION SEDIMENTARY FEATURES IN THE ROMANIAN PLAIN AND DOBROGEA

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1.1. Introduction

Most of the Romanian landforms units are covered by loess deposits. Overall, the loess areas extend over approximately one third of Romania's territory. The bulk of the loess cover in Romania piles up in the Romanian Plain and in Dobrogea.

The northern part of the Lower Danube Plain, on the Romanian territory, is the Romanian Danube Plain (Fig. 1). On the southern side of the Danube River extends the Bulgarian Plain. The Romanian Plain is bounded to the north by the hilly sub-Carpathian zone.

Dobrogea occupies the western area of the Lower Danube Plain, outlined by the Danube River and the Black Sea coastal zone (Fig. 1).

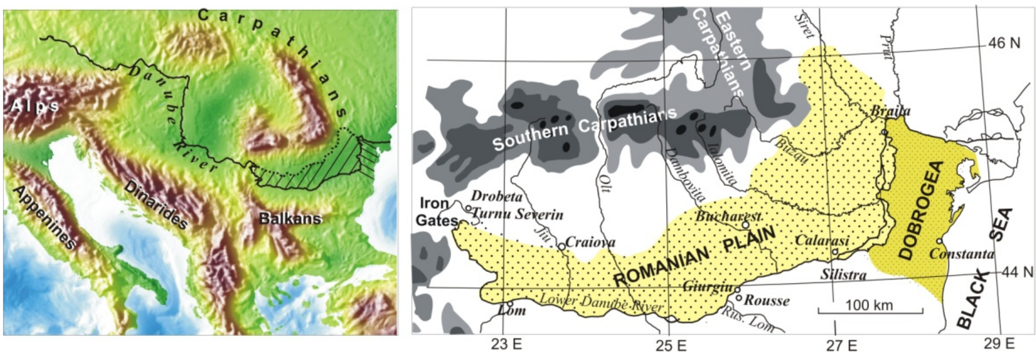

Fig. 1 – The geographic setting of the Romanian Danube Plain and Dobrogea in the Danube River area and in the Lower Danube Basin. The northern limit of the Romanian Plain after Conea (1970a).

Loess study began in Romania by the end of the 19th century. The first descriptions of the Romanian loess deposits are due to K.F. Peters (1867,) and Grigore Ştefănescu in 1895. Ludovic Mrazec discussed the aeolian origin of the loess from Romania (1899).

Before the World War I Gh. Murgoci, Em. Protopopescu-Pache, P. Enculescu, D. Rusescu, N. Florov, C. Bratescu, M. Popovăţ, N. Al. Rădulescu and others were deeply involved in loess study.

Detailed studies of the loess profiles and paleosoils were conducted by N. Florov and C. Bratescu between the two world wars.

After the Second World War, the loess-palaeosol sequences are studied particularly by pedologists (Ana Conea, M. Popovăţ, N. Bucur, N. Barbu and others) and by hydrogeologists (E. Liteanu, C. Ghenea, T. Bandrabur and others). Ana Conea appears as the most prominent of the Romanian loess scientists. Her study of the Dobrogean loess is well known.

Provenance of the loess clastic material was frequently approached by Romanian scientists. The strongest arguments were provided by the mineralogical studies carried out by V. Codarcea (Codarcea and Ghenea 1975 and 1976; Codarcea and Bandrabur, 1977). A turning point in the evaluation of the loess detritus source was the study of Smalley and, Leach (1978), when the part played by Danube River was brought into discussion.

Loess dating in Romania started with the stratigraphic classical method, championed by E. Liteanu and A. Conea. Since the last decades of the 20th century the magneto-stratigraphic investigation began with the studies of S.C. Rădan and, later, C.G. Panaiotu and its co-workers. After the year 2000 the dating efforts continued and intensified, involving new methods, and an international scientific effort. The Romanian loess research history, focused on loess dating, is masterly presented by Rădan (2012).

In concert with dating, the magnetic susceptibility investigations of the Lower Danube carried out in the areas of the Romanian Plain and Dobrogea, revealed environmental conditions of the loess accumulation (Panaiotu *et al.*, 2001; Buggle *et al.*, 2009; Fitzsimmons and Hambach, in press).

1.2. Sedimentary succession in the Romanian Plain and Dobrogea loess

In the Romanian Plain and in Dobrogea, as in many other loess areas, the vertical succession of the loess deposits is characterized by the alternance of loess and paleosoil units.

The existence of the paleosoil intercalation was known since a long time in Romania. Florov (1927) was one of the first Romanian scientists who focused on this subject.

The earliest systematic study of the Romanian loess was carried out by Coteţ (1957), in the westernmost area of the Romanian Plain. The loess columns presented by Coteţ (1957) from the area between Olt River and Danube River revealed the existence of a variable number of loess (and loess-like) beds in the succession. The presence of five loess units, alternating with four paleolsoil units, was recorded in only one location (Fig. 2 A and D).

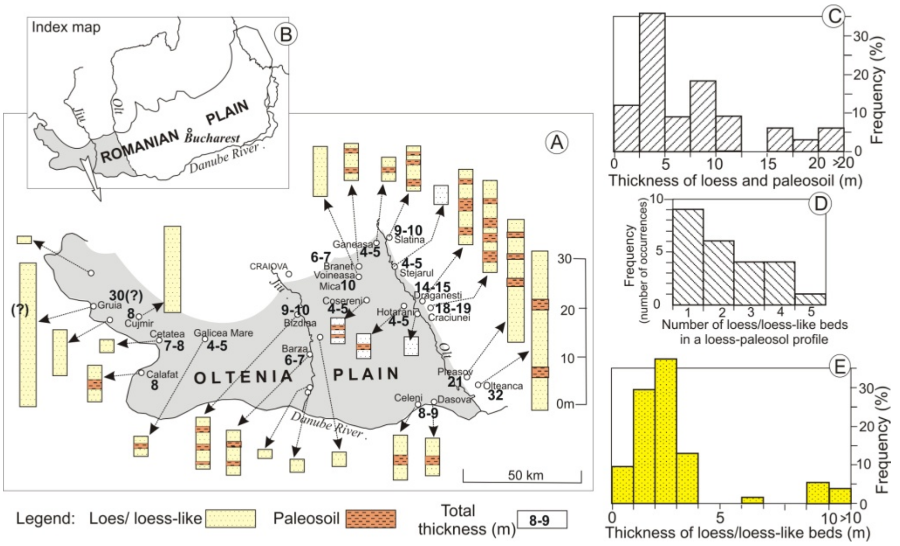

Fig. 2 – Loess/loess-like - paleosol succession in profiles from the Oltenia Plain (western part of the Romanian Plain). Figures on the sketch show thickness (in meters) of the succession. Based on data from Coteţ (1957). A. Loess/loess-like - paleosoil profiles. B. Location of the Coteţ (1957) study area in the Romanian Plain. C. Thickness of the loess/loess-like - paleosoil succession in a study section. D. Number of the loess/loess-like beds within an individual study section. E. Frequency of the loess beds thickness values.

The other loess columns show less than five loess beds. In the western extremity of the study-area investigated by Coteţ, several vertical loess sections, with 7 to 30 m thickness, are devoid of paleosoil intercalations (Fig. 2 A and D).

The sedimentary succession of the Dobrogean loess deposits is shown in several publications. The most detailed data are presented by Conea (1970b) (Fig. 3). Rădan and Rădan (1984 a and b), Balescu et al. (2003) and Munteanu *et al*. (2008) displayed loess columns in their loess chronology papers (Fig. 4).

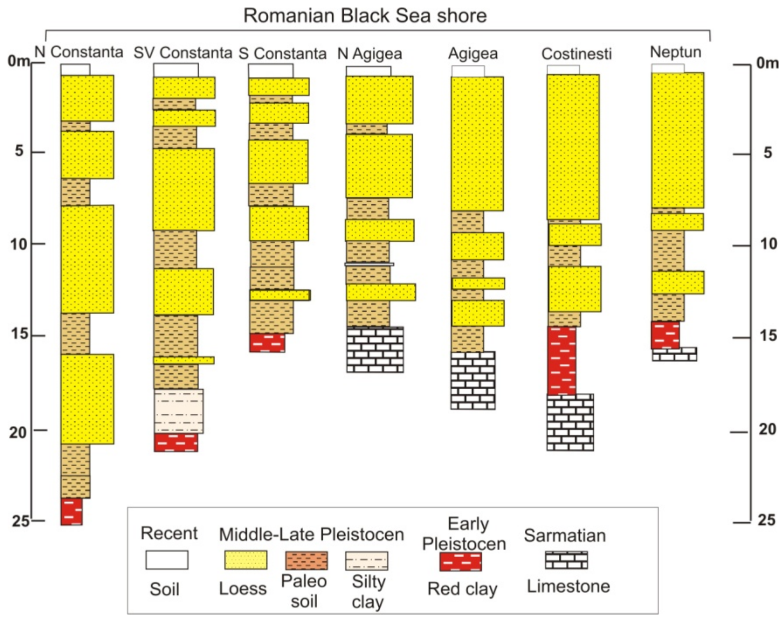

Fig. 3 – Loess deposits succession in south Dobrogea area.Redrawn, from Conea (1970b)

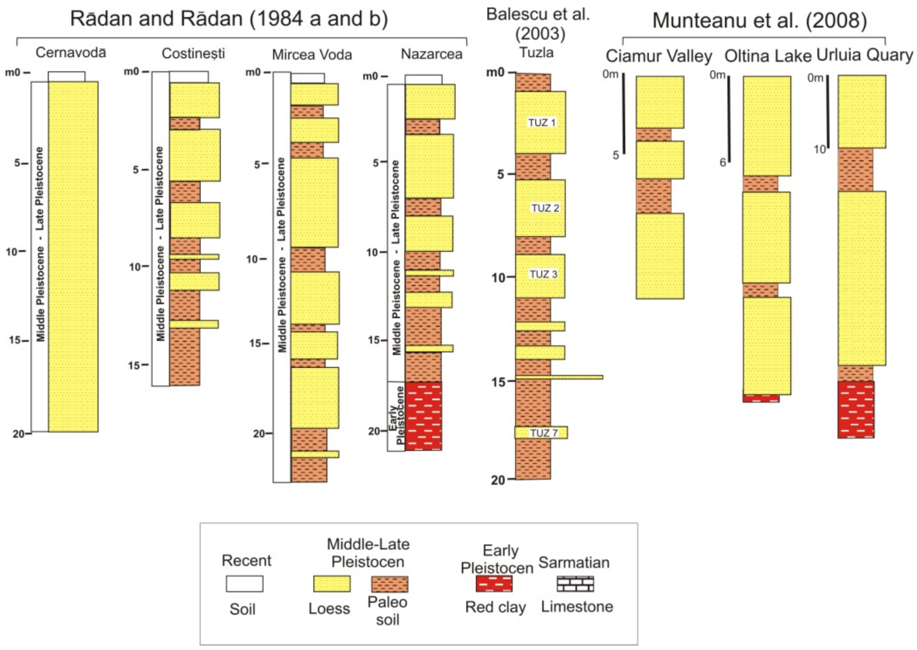

Fig. 4 – Loess deposits succession in south Dobrogea area. Redrawn, from Rădan and Rădan (1984 a and b), Balescu et al. (2003) and Munteanu et al. (2008).

As Conea (1970b) pointed out, the number of loess unit in a section is variable in different zones of Dobrogea. The largest number of loess units (seven) is shown by the Mircea Voda section

(Rădan and Rădan, 1984a) (Fig. 4).The individual thickness of the loess units is also highly variable (Fig 5C).

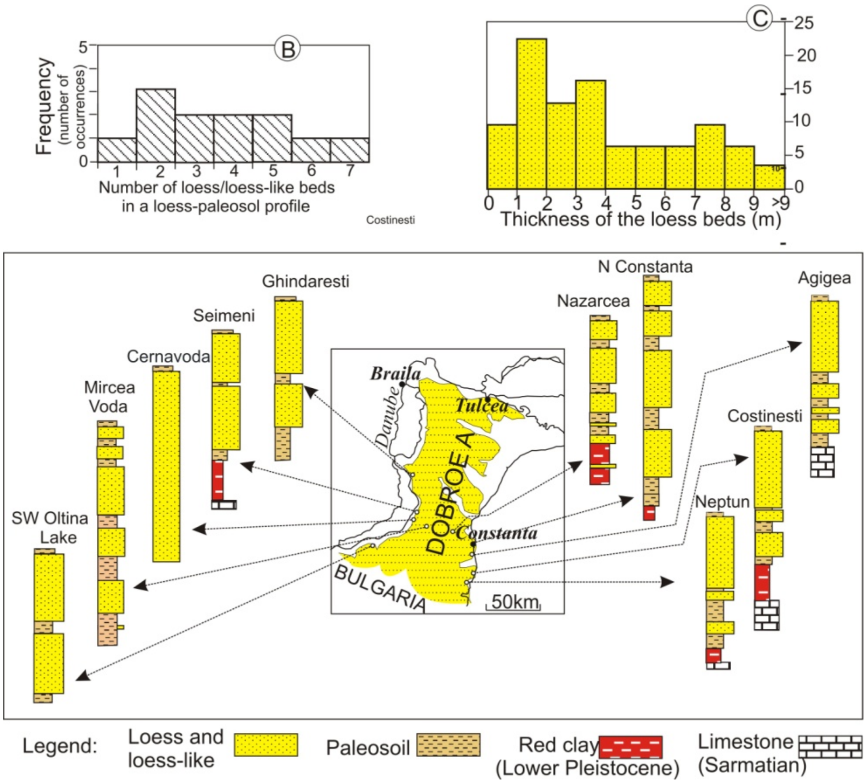

Fig. 5 – Bedding characteristics of the loess - paleosoil successions in Dobrogea. A. Selection of Dobrogean loess-paleosoil columns. From Conea (1970b), Rădan and Rădan (1984a and b), Munteanu et al., (2008). B. Number of loess/loess-like beds within a study section. C. Thickness values distribution of the individual loess/loess-like beds.

Most of the loess units are 1 to 4 m thick. Conea (1970b) mentioned thickness more than 13m. A 20m thickness section without paleosoil interbeds was reported by Rădan and Rădan (1978a) at Cernavoda locality.

1.3. The areal variations of the loess grain size in the Romanian Plain and Dobrogea

Conea (1970b) distinguished three main grain-size/lithology types of loess in Dobrogea: the sandy loess (sandy-silt with approximately 18% clay particles), the typical loess and the fine-grained loess (including around 40% clay). The loess-like deposits represent the fourth main type, referring to the sediments with loess aspect, but with more clay fraction or more sand fraction than the three main loess varieties.

In the Romania Plain area only two types of loess were mapped by Conea (1970a), together with the loess-like type (Fig. 6). The coarsest-grained loess variety, the loam and sandy loam, occurs near to the Danube River. The western part of the occurrence, shaped as a narrow (less than 5 km wide), discontinuous and irregular band appears from the Jiu River mouth to the town of Giurgiu. In the eastern part of the Romanian Plain, between the cities of Călărasi and Brăila, the sandy loess builds a wider strip (up to 15 km) which extends along this Danube River course.

The typical loess deposits succeed the sandier loess zone, occurring more toward the Carpathian hills. In the western area, between Turnu Severin and Giurgiu, the typical loess shows a narrow crop out zone, which enlarge very much in the eastern Romanian Plain zone.

The Romanian Plain loess-like type, the finer-grained unit mapped by Conea (1963) as the silty loam facies, occupies a more internal zone, located more toward the hilly area. Unlike the typical loess deposits, the loess-like sediments are poorly developed in the eastern Romanian Plain.

On the loess textural map of the Romanian Danube Plain, Conea (1963) (Figs. 6 and 7) marked the loess areal advance upstream some Lower Danube tributaries. Along the Olt River both the sandy and the silty loess facies extend as narrow strips, about 55 km upstream from the river mouth (Fig. 6).

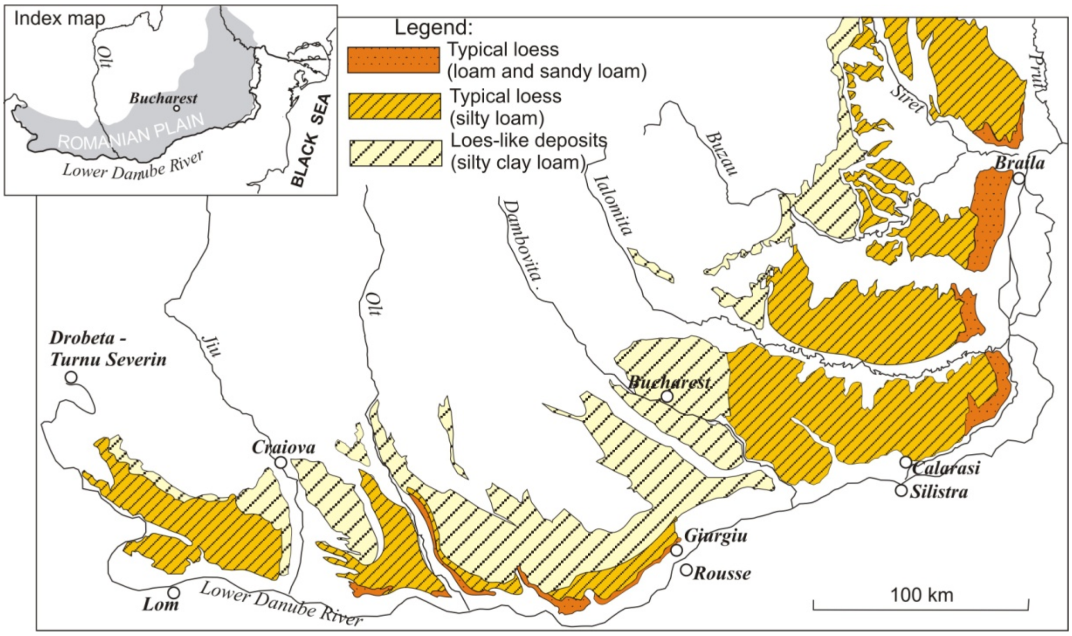

Fig. 6 – Textural types of loess and loess-like deposits in the Romanian Plain area. From Conea (1970a).

The loess and loess-like deposits mapped by Conea (1970b) in Dobrogea (Fig. 7) are part of a succession which becomes increasingly finer-grained, from the Danube River to the Black Sea shore. The series of loess/loess-like deposits, especially the two upper loess units, begins with a narrow sandy-silty strip close to the Danube River, which turns silty-clayey eastward. The top units of the loess sequence show simultaneous fining upward and lateral fining trends (Conea, 1970b) (Fig. 7). The loess textural types mapped by Conea (1970b) in Dobrogea make up a lateral succession which becomes finer and finer from the Danube River toward the Bkack Sea.

Regarding the entire loess accumulation zone from the Romanian Plain and from Dobrogea, the investigations made by Conea (1963) and Conea (1970b) point out a large scale textural variation trend: the loess and loess-like deposits become finer-grained away from the Danube River, toward the Carpathian hills (in the Romanian Plain) or to the Black Sea (in Dobrogea) (Jipa, in press).

Another significant grain-size variation trend revealed by Conea (1970b) pointed out to a feature of the individual loess units interbeding in the vertical succession. The textural composition of the loess units shows a systematic fining-upward variation. This feature revealed by Conea (1970b) from Dobrogea was also remarked in the eastern Romanian Plain loess by Codarcea and Bandrabur (1977).

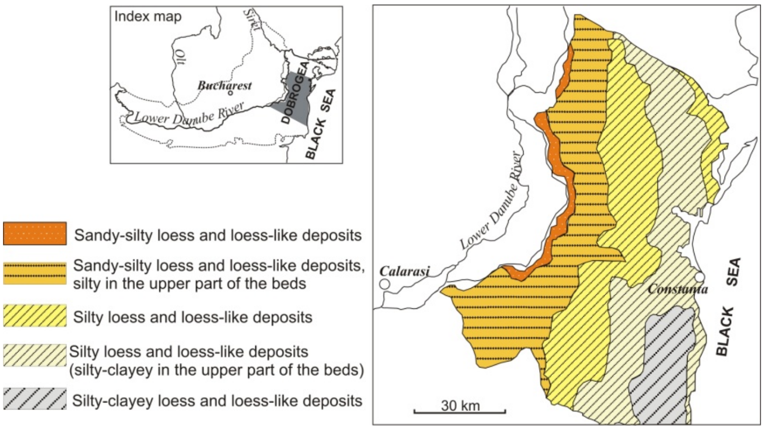

Fig. 7 – Grain-size types of loess deposits representing the parental source of the modern soil in Dobrogea. From Conea (1970b).

1.4. Thickness variability of the loess cover in the Romanian Plain

In the Romanian Plain area the loess cover shows a rather small thickness, usually not exceeding 40-45 m. The highest thickness value, reaching 55 m, was reported by Liteanu (1963) from the Hagieni locality, in the south-eastern part of the Plain, close to the Danube River.

The first image of the loess and loess-like deposits from the entire Romanian Plain was presented by Conea (1970a) (Fig. 8). Using only three large thickness divisions, the author revealed several important trends of the loess thickness areal distribution:

- the thickest loess deposits are located in the vicinity of the Lower Danube River course;
- the thinnest deposits (mainly the loess-like type) occur toward the piedmont area, that is in the direction to the of the Southern Carpathians hilly zone;
- along the Lower Danube River course the loess cover is thinner upstream the Jiu River mouth, while the thicker loess deposits are largely developed downstream (mainly in the Călăraşi area).

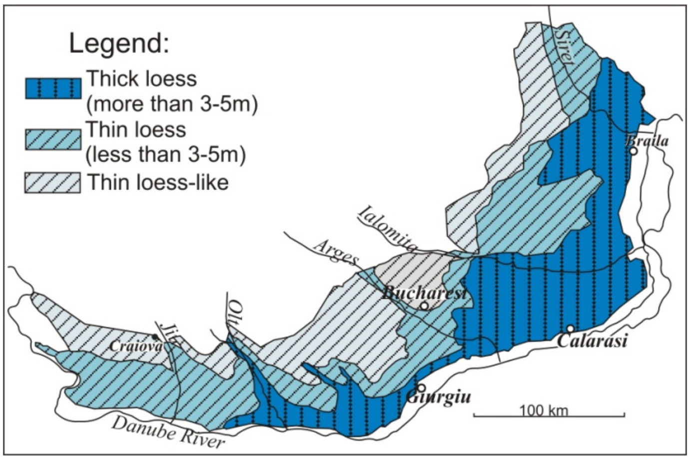

Fig. 8 - Sediment thickness image of the loess cover in the Romanian Plain. Redrawn from Conea (1970a).

Codarcea and Bandrabur (1977), in the eastern Romanian Plain, and Ghenea *et al*. (1980) in the western Plain carried out detailed investigations of the loess and loess-like deposits. The isopach maps the authors produced (Fig 9 A and B) modified the image of Conea (1970a), but confirmed its main connotations. Codarcea and Bandrabur (1977) established the location of the thickest loess deposits (20 to 50 m) in the south-eastern part of the Romanian Plain. The 20 to 40 m thick deposits extend westward only to the Jiu River (Ghenea et al., 1980) (Fig. 9B). The Codarcea and Bandrabur (1977) map, which covers a larger area, clearly show the sediment thickness diminishes toward the Carpathian hilly area (Fig. 9A).

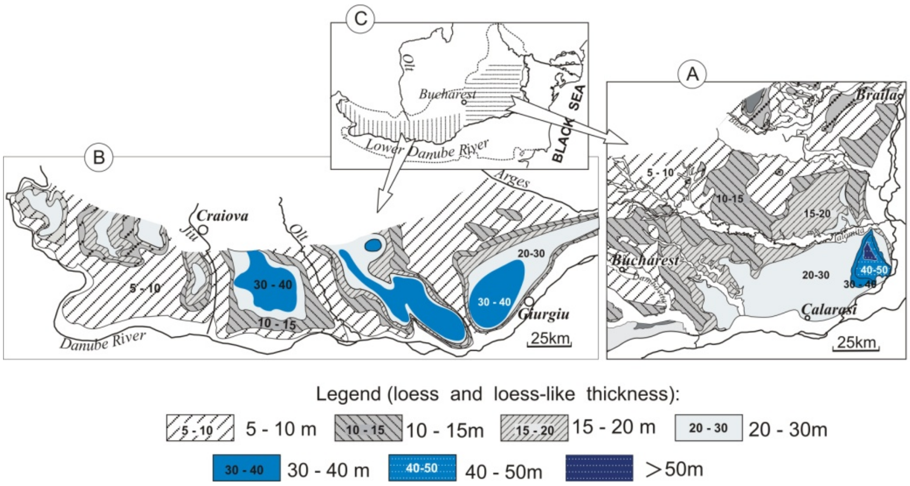

Fig. 9 – Thickness of loess and loess-like deposits in the Romanian Danube Plain. A and B. Isopach maps by Codarcea and Bandrabur (1977) (east of Damboviţa River) and Ghenea et al.(1980) (west of Damboviţa River). C. Study area locations.

The Romanian Plain loess and loess-like areal distribution proves to have a pattern similar with the grain-size variation in the same area (Jipa, in press). The sediment thickness is large in the vicinity of the Danube River and greatly diminishes away from the River, in the direction of the Carpathian area.

1.5. Loess-like deposits

In accordance with the widespread use of the term, in Romania, sedimentary deposits externally similar to the loess, but with different grain-size composition, are termed loess-like (loessoid) deposits. Conea (1970b) specified that the loess-like sediments are either finer-grained (more than 40-50% clay) or coarser-grained (high sand particles content) compared to the typical loess sediment.

Loess versus loess-like was a rather highly discussed subject among the Romanian Plain scientist. Many investigators realized that in the western Romanian Plain area, the deposits with a high percentage of clay particles are dominant. Coteţ (1957) argued that *"today, it is hard to speak of primary loess on large areas of the Oltenia plain where secondary loess deposits prevail"*. Liteanu and Ghenea (1966) even suggested a radical change in terminology: "*the old loess term should be dropped... and replaced with the loessoid deposit term"*. Conea *et al*. (1966) pointed out that "*northwards* (the loess) *pass into loess-like deposits showing a silty clay texture, devoid of coarse particles at the beginning, and afterwards containing coarse particles in large quantities, particularly in the piedmont region, as a function of the deluvial origin of this material*". Liteanu and Ghenea (1966) mentioned that in the proximity of the hilly area, coarse-grained deposits (small fine gravel lenses and coarse sand beds) and cinerite lenses are intercalated into the loess-like deposits.

It was Conea (1970a) who placed this feature in the general content of the entire Romanian Plain (Fig.7), showing the areal distribution of the loess and loess-like deposits.

Some of the coarse-grained loess-like deposits from Dobrogea, are regarded as resulting through the secondary incorporation of the material resulted from local erosion of the older consolidated rocks (Conea, 1970b).

1.6. On the provenance of the loess detrital material in the Romanian Plain and Dobrogea

In the area close to the Southern Carpathian hills, the loess researchers discerned features indicating Carpathian clastic supplies delivered to the loessoid sedimentation area of the Romanian Plain. This concept relies on the coarse sediments, fine gravel or coarse sand, interbedded in the loess-like deposites from the northern periphery of the Romanian Plain (Liteanu, 1953 and 1961; Liteanu and Ghenea, 1966). Conea *et al*. (1963) believed that the coarse particles from the loess-like sediments are of deluvial origin. The Codarcea and Bandrabur (1977) mineralogical data indicate similarities between the clastic material of the Romanian Plain loess-like deposits and the Carpathian detritus accumulated in the hilly area.

As mentioned above in this paper, Conea's (1970a) Romanian Plain map shows that the occurrence surface of the sandy loess and typical loess extends upstream some Danubian distributary rivers, the Olt River representing a good example. This shows these rivers were active during the loess accumulation time, and discharged Carpathian sediments in the loess basin (Jipa, in press).

The mineralogical study of the Dobrogean loess provided arguments to Codarcea and Ghenea (1976) to point out the detrital contribution of three source areas. The authors stated that the sandy loess from the proximity of the Danube River provides mineralogical data indicating the provenance of its detrital material from the Danubian alluvial sediments. In the central part of Dobrogea the investigation revealed loess mineralogical characteristics matching the mineralogy of the sand from the western Black Sea shoreline, suggesting the source-area role played by the shallow marine zone. Mineralogical investigation carried out by Codarcea and Ghenea (1976) pointed out that in several restricted area from the North Dobrogea the loess mineral particles derive from strictly local sources.

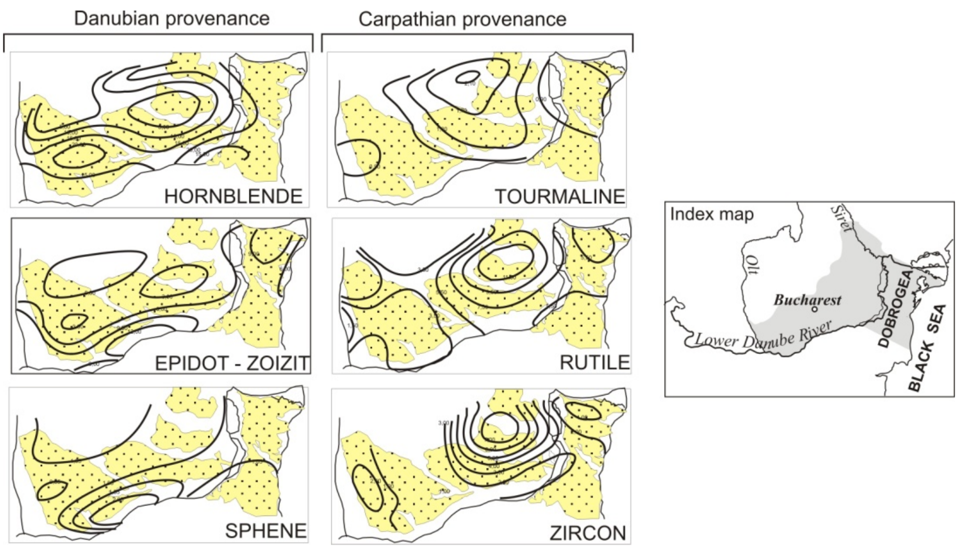

Fig. 10 – Variation trend of the loess heavy minerals frequency in the eastern Romanian Plain and Dobrogea. From Andăr and Codarcea (1979). The authors conclude that the pattern of the trend surfaces of some heavy minerals suggest a Danubian source (graphs on the left side)

and a Carpathian provenance (right side graphs). Dotted surfaces show loess areas.

The statistic-mathematic investigation of loess and loess-like samples collected from central and eastern Romanian Plain and from Dobrogea (Andăr and Codarcea, 1979), revealed that the content of the different heavy mineral species have an independent areal variability. The polynomial surfaces calculated for the distribution of some heavy minerals content show the decrease of the minerals frequency to the north (NE or NW) or to the south (SE or SW) (Fig. 10). The authors interpreted these variations as indicating the provenance of the heavy minerals from the Carpathian area or from the Danubian alluvial sediments.

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2. LOESS DATING IN THE ROMANIAN PLAIN AND DOBROGEA; AN OVERVIEW

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After a short presentation of the early history of the loess dating in the Romanian Plain and Dobrogea (starting ca 120 years ago), is presented the structure of the Table 1 (attached at the end of the Guidebook), in which the main contributions to the loess age knowledge, over the last half-century, are synthetised. Various methods were applied by a long series of Romanian authors, and also several foreign ones. Actually, the Table 1 reflects the main steps in the evolution of the Romanian loess investigation, passed since 1961 till present, particularly with regard to its age.

The Table is supported by several examples concerning the multi-proxy magnetic approach undertaken by the author both in the Romanian Plain and Dobrogea, during the last 30 years. Consequently, a series of magnetostratigraphic models or (palaeo)magnetic diagrams illustrate the contributions to dating of the loess - palaeosoil couples or the loess sequences only in some cases when in the investigated sections these deposits are developed without alternating with palaeosoil horizons.

2.1. Early history of loess dating in the Romanian Plain and Dobrogea

It seems that the history of the loess studies in Romania has begun 120 years ago. Murgoci (1910, cited by Conea, 1970) states that descriptions of the "fossil soils" were done in Romania at the end of the XIXth century by Gr. Ştefănescu (1892, 1895), and at the beginning of the XXth century by R. Sevastos (1908); even more, "*the age of the loess has been discussed by many geologists, same as in the other countries where this occurs*" (Murgoci, 1910, cited by Conea, 1970).

The first scientist who mentions the thick loess layers from *Dobrogea* is an Englishman, Spratt (cited by Conea, 1970), but the first who has correlated them with similar deposits of other countries of Europe, particularly with the loess from Austria basins, is an Austrian, *i.e.* K.F. Peters (1867, cited by Conea, 1970); he refers also to the presence of the "red layers".

It is important to remark that after more than 60 years, Brătescu (1934, 1935; cited by Conea, 1970) studied several profiles of "loess - fossil soils" situated between Constanţa and Eforie. The results obtained by Brătescu over the fourth decade of the previous century are really impressive. Brătescu recognises "*three typical yellow loesses and the fourth at the base, continued under the water*", and he correlates them with the four Quaternary Glacial periods: *Günz*, *Mindel*, *Riss* and *Würm*. The "fossil soils", which separate them, are assigned by Brătescu to the Interglacials, and the "*black earth from the surface is postglacial, contemporaneous*" (Brătescu, 1934, cited by Conea, 1970). Moreover, Conea (1970) adds that Brătescu (1934) distinguishes "*a coloured loess interbedded within the upper loess stage*", which separates into two parts the *Würm Glacial* (*i.e.*, *Würm 1* and *Würm 2)*. Conea (1970) remarks then the great value of the conclusions which Brătescu (1934) has reached, particularly with regard to the description and the interpretation relating to the "*fossil soils*". Anyway, she makes the observation on the progresses recorded in the Quaternary study in the following decades, *e.g.* the insertion of the "*stadial and interstadial subdivisions within the Glacial periods*", as well as of the "*more analytical and more thoughtful research methods*". Some other contributions to the investigation of the loess and "fossil soil" deposits from Dobrogea are reviewed by Conea (1970). A synthesis of the researches that were carried out on the "fossil soils" from the eastern Dobrogea and a correlation with the existent data for the Central Europe is also performed by Conea (1967, cited by

Conea 1970). As regards the northern Dobrogea, Conea (1970) mentions the paper of Grumăzescu and Grumăzescu-Stoicescu (1967), in which the authors have an attempt to date as "*Mindel – Mindel-Rissian*" the median "*lutaceous-sandy complex*" of the three lithological complexes identified within the cover of the Quaternary deposits from that area.

Actually, the study of the loess and "fossil soil" has begun in the Romanian Plain, where Murgoci and his co-workers, based on a considerable number of boreholes, succeeded to present the first total view on the repartition, origin and the age of the loess in Romania (Conea, 1970). As regards the age, initially, in 1910, Murgoci (cited by Conea, 1970) considers the loess as a Late Pleistocene formation, but afterwards (1920), he assigns the loess to the last two Glacials. The palaeosoils are formed in a Mediterranean climate, in general warmer and with a higher humidity, and the loess in a dry and colder climate. Later, Brătescu (1937, cited by Conea, 1970) considers that in Romania, as in the Central Europe, within a complete profile, the number of "loess horizons" can give us information on the number of "Glacial periods", while the number of "fossil soil horizons" could indicate the number of "Interglacial periods". Conea (1970) remarks then the stratigraphic importance given by Brătescu (1937) to the "fossil soil bands" and the "loess horizons", recommending this criterion, together with the palaeontological and the geographic (with regard to the relative altitudes) criteria, as applicable to dating of the terraces.

After a series of references concerning the contributions of the geographers to the investigation of the fossil soils and of the chemists-pedologists to the laboratory studies of the loess, particularly from the Romanian Plain and Dobrogea, Conea (1970) gets on to the period when the hydrology team of the State Committee of Geology, coordinated by E. Liteanu, became involved in the study of the Quaternary deposits.

Conea (1970), in her monograph on the loess from Dobrogea, including however some sub-chapters dedicated to other regions from Romania, mentions various papers published within the 1952 – 1967 interval, in which the authors approach the loess horizons or the "loessoid deposit", as well as the "fossil soils" from the Romanian Plain. In the conclusions from the end of the Chapter on the "*Hystory of the researches*", she emphasises that "*although the research method in all the studies is more or less the same, the interpretation of the results, in some cases, is totally different. In fact, this reflects two conceptions on the evaluation of the reports between the Glacials and Interglacials, on the one hand, and the deposition of the loess and the fossil soil forming, on the other hand. Several of them – the most part* (some references are given; among them, Conea, 1967) – *assert the conception ... that the loesses from the temperate zone are considered periglacial deposits, corresponding to the Glacials, and the fossil soils to the Interglacials. Others* (some references are given) *assert the conception that the loesses are Interglacial formations and the fossil soils are Glacial formations*".

2.2. Dating the loess: Authors and methods over the last half-century

The main contributions of the Romanian and foreign authors with regard to dating of the loess – palaeosoil sequences from the Romanian Plain and Dobrogea are systematised within the Table 1. The synopsis starts from the works coordinated by E. Liteanu at the State Committee of Geology, more exactly, from his synthesis (published in 1961) on the "loessoid deposits" stratigraphy for three sectors of the Romanian Plain, explicitly referred to by Conea (1970), and ends with the recent contributions of different authors brought after about a half-century.

The attempt towards such a synopsis, carried out in this "historical framework" (defined by the last 50 years), is presented within the table structure, in the order (Table 1): (1) author/year; (2) methods used to derive/confirm the chronostratigraphy/age of the loess/palaeosoil horizons; (3)

location of profiles/sections; (4) investigated loess – palaeosoil sequences; (5) derived/confirmed ages of the loess/palaeosoil horizons.

Therefore, in the *column 1* of Table 1, it is followed a chronological order, from the contributions of Liteanu (1961), Conea (1969, 1970) and Ghenea & Codarcea (1974), to Rădan *et al.* (1983, 1984, 1990), Rădan & Rădan (1984a,b; 1998), Rădan (1998), Rădan (2000, in Enciu *et al.*, 2000; updated by Rădan, 2012), Panaiotu *et al.* (2001), Bălescu *et al.* (2003), Buggle *et al.* (2009) and Timar-Gabor *et al.* (2009, 2011), to reach at the end at the results of Bălescu *et al.* (2010), Vasiliniuc *et al.* (2011), Bălescu (2012), Fitzsimmons *et al.* (2012) and Buggle *et al.* (2012). New contributions to the Romanian loess investigation have recently been added (*e.g.*, Fitzimmons & Hambach, 2013; Jipa, 2013).

Taking into consideration the methodological point of view (*column 2,* Table 1), particularly with regard to the age determination of the loess – palaeosoil sequences, there are several stages to be relieved, *i.e.*: the classic stratigraphy/pedostratigraphy; geological – climate stratigraphy ("glaciation", "stade/stadial", "interstade/interstadial", "interglaciation/ interglacial" – http://www.inqua-saccom.org/stratigraphic-guide/); the palaeogeomagnetic polarity stratigraphy/magnetostratigraphy; the oxygen isotope stratigraphy, and the correlation of the magnetic susceptibility variations (with depth) with the benthic oxygen isotope record from ODP Site 677 (situated in the Eastern tropical Pacific; $1^0$12'N, $83^0$44'W; Shackleton *et al.*, 1990); the astronomically tuned cyclostratigraphy/Mylankovitch cycles; the orbitally tuned SPECMAP (SPECtral MApping Project) oxygen isotope records derived from deep-sea sediments (Martinson *et al.*, 1987; Opdyke & Channell, 1996); the palaeopedological – geochemical multiproxy approach (Buggle *et al.*, 2012); the luminescence/optical dating [ThermoLuminescence (*TL*); Optical Stimulated Luminescence (*OSL*)/in combination with the single-aliquot regenerative-dose (*SAR*) protocol, *i.e.* the *SAR-OSL* technique; Infrared Stimulated Luminescence (*IRSL*)].

As regards the location of the profiles/sections (*column 3*, Table 1), these are located in both the Romanian Plain and Dobrogea (Fig. 1). Among the main sampling zones for the loess and palaeosoil horizons are the following (from west to east; Fig. 1): *Drănic* (**Dn**), *Zimnicea borehole* (**Zm**), *Malu Roşu* (**MR**), *Mostiştea* (**Ms**) (in the *Romanian Plain*), and *Urluia* (**Ur**), *Cernavodă*(**Cv**), *Mircea Vodă* (**MV**), *Cuza Vodă* (**CV**), *Nazarcea* (**Nz**), *Popina Isle* (**PIs**; Razelm Lake), *Jurilovca* (**Jv**; northern border of Goloviţa Lake), *Tuzla* (**Tz**), *Costineşti* (**Cs**) (in *Dobrogea*).

It seems (see *column* 4, Table 1) that maximum six loess horizons alternating with six palaeosoil horizons have generally been investigated within a section, *e.g.*: *Mircea Vodă* (after some authors, *i.e.*, Rădan *et al.*, 1990, 7 **L**/**S** couples are mentioned, but the last **L7**/**S7** doublet has not been palaeomagnetically investigated; *e.g.*, Rădan & Rădan, 1984a; Rădan *et al.*, 1990), *Cuza Vodă*, *Nazarcea-Ovidiu*, *Costineşti* (Conea, 1970; Ghenea & Codarcea, 1974; Rădan *et al., 1984,* 1990; Rădan & Rădan, 1984a,b; Ghenea & Rădan, 1993; Buggle *et al.*, 2009). Apart from these, there are the following two sections/profiles: (a) *Tuzla* section (Dobrogea; **Tz**, in Fig. 1), where Bălescu *et al.* (2003) mention seven palaeosol complexes (**S1** to **S7**) below the surface soil, and seven interbedded loess horizons (**L1** to **L7**); the expected geological age of **L7** is 800ka (see Table 1), the authors mentioning the *Oxygen Isotope Stage 20* (see Table 1); (b) *F3 - Zimnicea* borehole profile (Romanian Plain; **Zm**, in Fig. 1), in which – within the basal loess (**L8**) of the ca. 30 m thick loess-palaeosoil sequence [composed by **L1** to **L8** loess horizons, and **S1** to **S7** (**S8 ?**) palaeosoil horizons, respectively] – the *Matuyama/Brunhes boundary* (*MBB*; 781 ka ago) and the *Marine Oxygen Stages* (*MIS*) *19* and *20* (*MIS 21* ?) were located (Rădan, 2000, in Enciu *et al.*, 2000; updated by Rădan, 2012; see Table 1 and Fig. 7).

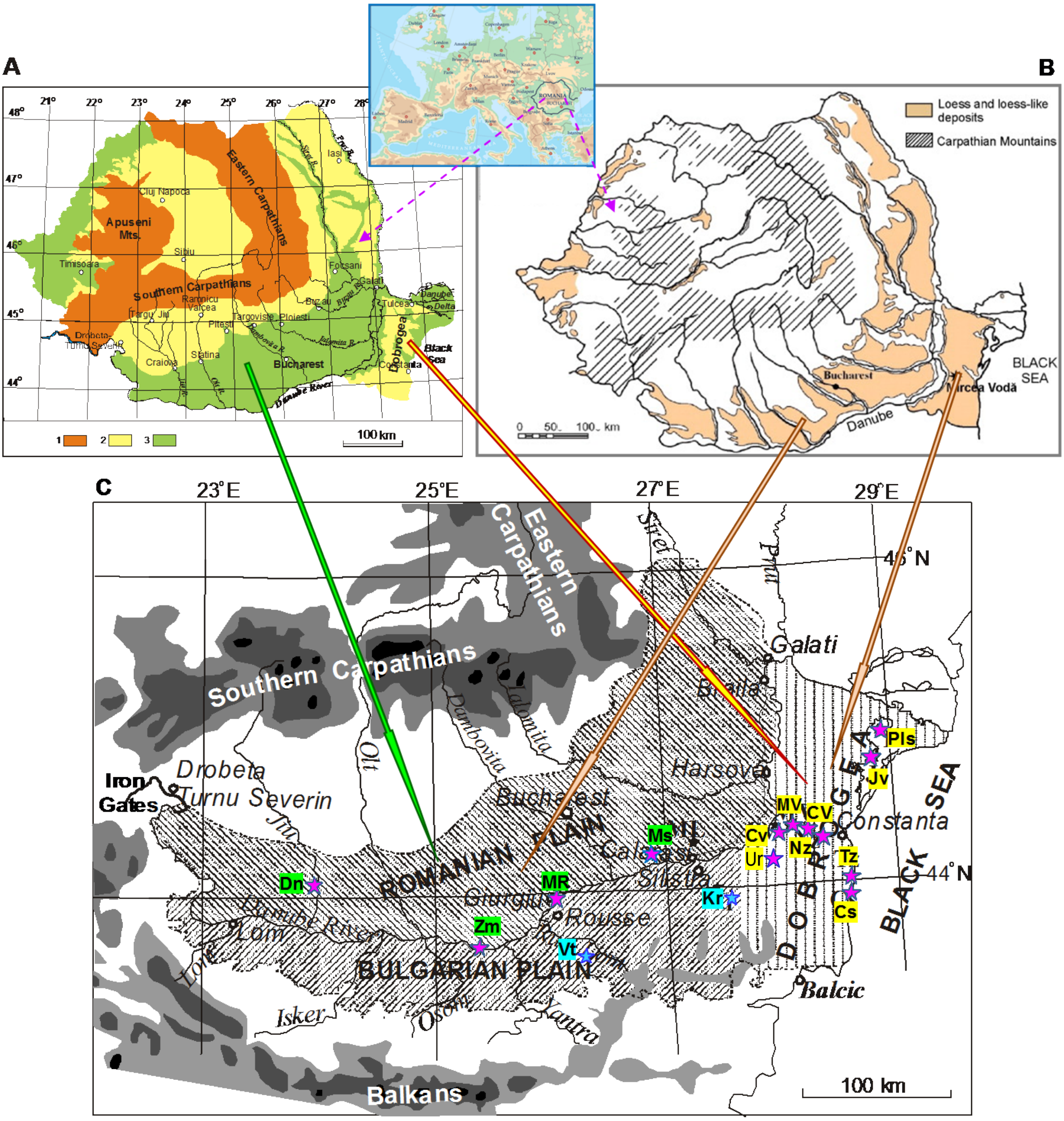


Fig. 1. Location of the most important loess - palaeosoil sections in the Romanian Plain and Dobrogea (Romania), which were investigated for dating by different authors through time. **A**. Simplified physical map of Romania. 1 – Highland relief; 2 – Hilly relief; 3 – Lowland relief (after Jipa & Olariu, 2009). **B**. Map showing the distribution of loess and loess-like deposits in Romania (reproduced from Timar-Gabor *et al.*, 2011). **A-B** *insertion*: Romania location within Europe (http://www.romaniatourism.com/romania-maps/europe-map.html); **C**. The Lower Danube Plain and its main areal subdivisions. The northern limit of the Romanian Plain, after Conea (1970). The southern Bulgarian Plain boundary, from Fotakieva & Minkov (1966). Location of dating loess sections. a) *Romanian Plain*: **Dn** – Drănic; **Zm** – Zimnicea (borehole); **MR** – Malu Roşu; **Ms** – Mostiştea; b) *Dobrogea*: **Ur** – Urluia; **Cv** – Cernavodă; **MV** – Mircea Vodă; **CV** – Cuza Vodă; **Nz** – Nazarcea; **PIs** – Popina Isle (Razelm Lake); **Jv** – Jurilovca (Goloviţa Lake); **Tz** – Tuzla; **Cs** – Costineşti (**C** – after Jipa, *in press*, with modifications and additions of some loess section locations). Location of two more sections, situated in the Bulgarian Plain (Bulgaria), are added:
Vt – Viatovo; **Kr** – Koriten (after Jordanova *et al.*, 2007).

Finally, in the *column 5* of the Table 1, the data about the suggested/derived/ confirmed ages of the loess and/or palaeosoil horizons are inserted, according to the authors and to the various dating methods that have been used over a half-century. Consequently, the loess – palaeosoil sequences investigated in the Romanian Plain and Dobrogea, generally the lowermost palaeosoil horizon being **PsVI/S6** (three exceptions were above mentioned, but one is concerning a borehole), are not older than 781 ka, according to the palaeomagnetic data (*e.g*., Rădan *et al*., 1984; Pagač, 1990; Table 1). It means that the primary/Characteristic Remanent Magnetisation (**ChRM**) identified in the loess and palaeosoil samples showed a normal polarity, which was assigned to the *Brunhes Chron* (*C1n*). The *Matuyama – Brunhes* boundary [*MBB* is located at 0.781 Ma, *cf*. to the ATNTS-2004 (Lourens *et al*., 2004) and ATNTS-2012 (Hilgen *et al*., 2012a,b)] has not been intercepted within the loess – palaeosoil sequences with six doublets **L-Ps/S**. When the loess horizons **L7** and **L8**, and the palaeosoil **S7** are present, the "expected geological age", according to the *Marine Oxygen Isotope Stages* of the *benthic $\delta^{18}O$ record*, is 800 ka (Bălescu *et al*., 2003; see Table 1), and consequently, the *MBB* is possibly located (Rădan, 2012; see Table 1 and Fig. 7).

2.3. Informative palaeomagnetic data relating to some loess and palaeosoil deposits from Dobrogea and Romanian Plain

Therefore, the Table 1 could represent an attempt towards a synopsis of dating the loess from the Romanian Plain and Dobrogea. Anyway, it is an essay to systematize significant contributions of the last half-century. Certainly, the Table is not exhaustive. The loess literature encloses a spectacular number of papers concerning the Romanian loess. Its diversity comes as well from the different methods applied to investigate the loess – palaeosoil sequences, in order to better know them in all the aspects which are possible nowadays. That's why in the first sub-chapter we are going to present some of the first palaeomagnetic results obtained on sections from Dobrogea, ones of them not more being approachable today.

2.3.1. Dobrogea

a) South Costineşti Section (**Cs**; location in Fig. 1C**)**. South of Costineşti resort, in the Black Sea shore, it was located one of the sections characteristic for the loess – palaeosoil doublets in the eastern part of South Dobrogea. The investigated profile (Fig. 2) description was made by Ghenea (1984, in Rădan *et al*., 1984).

The results of the informative palaeomagnetic investigation are illustrated in Fig. 2. The Characteristic Remanent Magnetisation (**ChRM**) (Rădan *et al*., 1984, 1990; also Fig. 2) and the petrogenetic features (Rădan *et al*., 1984; Ghenea & Rădan, 1993) were arguments for assigning the loess – palaosoil doublets from the South Costineşti Section to the Middle and Upper Pleistocene (Fig. 2). Moreover, two age determination were done by the ThermoLuminescence (TL) method, in the Lublin Laboratory (Poland), by dr. E. Król kindness. The dating carried out on a sample from the palaeosoil VI indicated an age of 650 ka ± 90 ka, which corresponds with the Günz – Mindel interglacial period (Ghenea & Rădan, 1993), and with the correlation to the Brunhes Chron *(i.e*, not older than 781 ka) (see Fig. 2).

b) Nazarcea Section (**Nz**; location in Fig. 1C). This profile was situated on the line of the present Poarta Albă – Năvodari Canal, between Nazarcea and Ovidiu. A description of the section is presented in a Guide-book for a KAPG field trip (Rădan *et al*., 1984) and in a previously published paper (Ghenea & Rădan, 1993). Taking into account the types of the fossil soils and the features of the loess out of which these were formed, the Nazarcea Section can be compared with the Costineşti Section (Ghenea & Rădan, 1993).

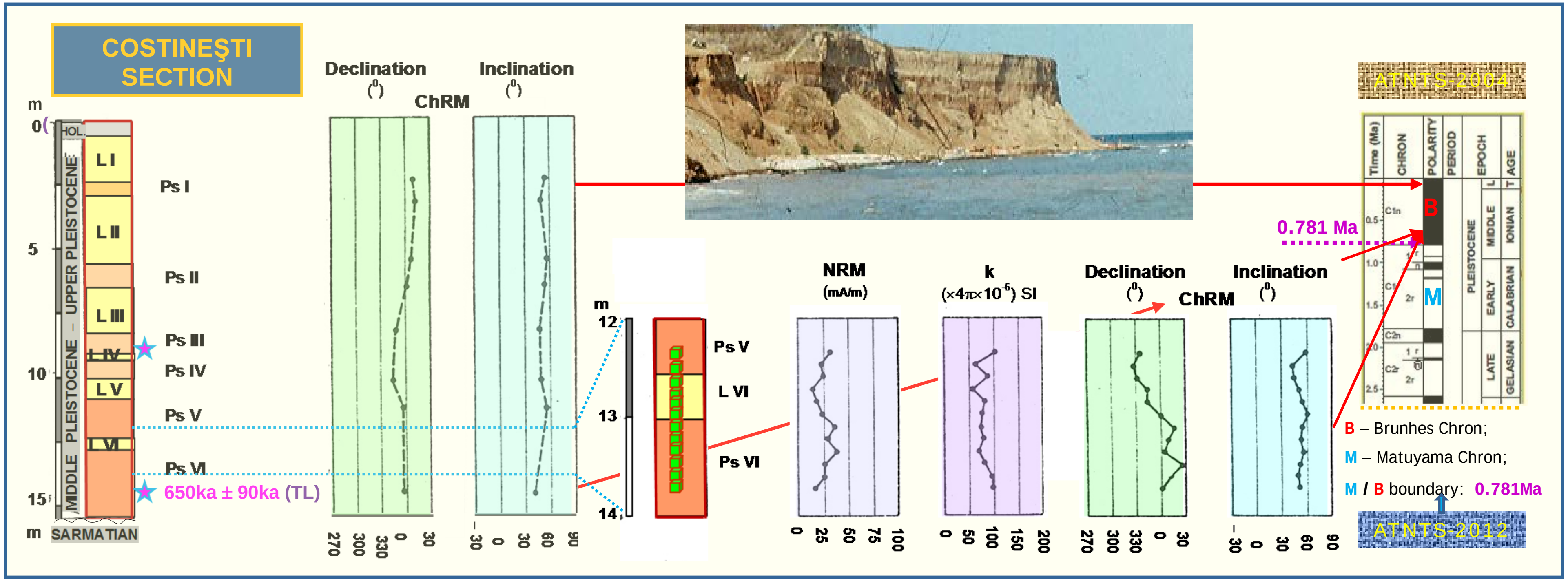


Fig. 2. (Palaeo)magnetic parameters characterising the loess - palaeosoil sequences investigated at Costineşti (Dobrogea, Black Sea coast; **Cs**, location in Fig. 1). Data after Rădan *et al*. (1984, 1990), Ghenea & Rădan (1993), with modifications and addings. *Legend*: loess; Palaeosoil (Chernozem type); Brown - reddish palaeosoil; Reddish palaeosoil, rich in clay; ★ Thermoluminescence dating [Lublin, Poland – Dr. E. Krol, pers. com.; sampling during the international KAPG field trip, in 1984 (Rădan *et al*., 1984)]. Sampling level [detail in the lower part of the Costineşti section; sampling (in 1983), together with dr. Alois Koči, from the Geophysical Institute of the Academy, Prague]; **NRM** – Natural Remanent Magnetisation; **k** – initial Magnetic Susceptibility (**NRM** intensity and **k**, before thermal cleaning); **ChRM** – Characteristic Remanent Magnetisation (primary magnetisation, isolated by using the stepwise thermal demagnetisation); ATNTS – Astronomically Tuning Neogene Time Scale (a fragment).

Yet, in the base of the Nazarcea Section, on about 6 - 7 m thickness, there occurs a continental formation, equally identified in other areas of Dobrogea. Concerning this profile, it is made up by brown-reddish clays, with manganese oxide patches, grey clays, glazy in aspect, which make up concoidal aggregates, red clays with grey patches, with quite many big gypsum crystals. Related to the red clay horizon in the base of the Nazarcea section, this was assigned to the Lower Pleistocene (Ghenea & Rădan, 1993). An attempt to perform a palaeomagnetic investigation on some samples collected from this horizon has not resulted in concludent data regarding the main features (declination and inclination) of the Characteristic Remanent Magnetisation (**ChRM**).

The results of the informative palaeomagnetic investigation obtained for the loess – palaeosoil doublets from the Nazarcea Section are illustrated in Fig. 3. The normal polarity recorded for all the analysed samples confirms the correlation to the *Brunhes Chron* (*i.e*., an age younger than 781 ka).

It is worth to remark that the palaeomagnetic data associated with the East Nazarcea lithostratigraphic column were integrated within the *Geological map of Romania*, scale 1:50,000, *Peştera sheet* (181a; L-35-141-A), published by the Institute of Geology and Geophysics (now, Geological Institute of Romania) (Rădan & Rădan, 1984b, in Ghenea *et al*., 1984). It was for the first time when a published geological sheet contains a palaeomagnetic diagram. In the same year, this new idea was applied as well for the "**Mircea Vodă**" **Section** (**MV**; location in Fig. 1C), in which case the lithostratigraphic column associated with the palaeomagnetic model were published within the *Geological map of Romania*, scale 1:50,000, *Medgidia sheet* (181b; L-35-141-B) (Rădan & Rădan, 1984a, in Ghenea *et al*., 1984).

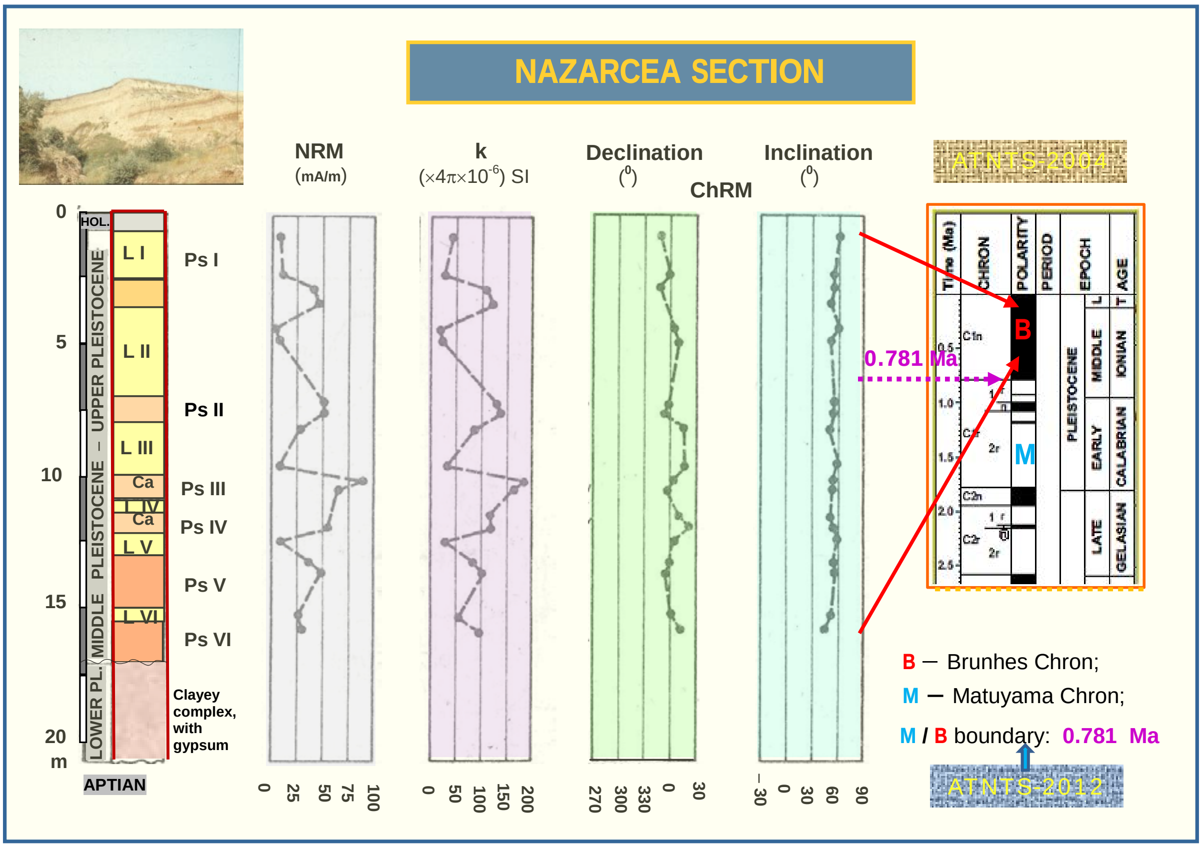


Fig. 3. (Palaeo)magnetic parameters characterising the loess - palaeosol sequences investigated at Nazarcea (Dobrogea, Poarta Albă – Năvodari Canal zone). Data after Rădan & Rădan (1984b), Rădan *et al*. (1984, 1990), Ghenea & Rădan (1993), with some modifications and addings. *Legend*: the same as in Fig. 2.

In this context, we add that in the South Dobrogea, beside of the "**Mircea Vodă**" **Section** (above mentioned), the "**Cuza Vodă**" and "**Cernavodă**" Sections were palaeomagnetically investigated, too (Rădan *et al*., 1984, 1990; Rădan, 1998). In the first two cases, loess - palaeosoil sequences were sampled, while in the latter, loess deposits only, as on the Bogdaproste Hill, the palaeosoils are not present within the studied profile.

As the "Mircea Vodă" Section is in the last time in attention of many researchers, being applied various methods of investigation (magnetic susceptibility stratigraphy and magnetostratigraphy included), we do not present our informative palaeomagnetic results. Moreover, this section is in attention of the present INQUA - SEQS field trip (see Chapter 4). Actually, the samples taken from the loess - palaeosoil sequences from the "Gherghina quarry" provided a normal polarity of the **ChRM**, confirming the correlation to the *Brunhes Chron* (0 – 0.781 Ma) and the Middle – Upper Pleistocene age (Rădan *et al*., 1984, 1990; Rădan, 1998; see also Table 1).

As regards the **"Cuza Vodă" Section** (**CV**; location in Fig. 1C), situated north of Medgidia, referring to the manner in which the loess and the palaeosoils horizons are developed, it can be compared with the "Costineşti" Section (Ghenea, in Rădan *et al*., 1984). Also 6 loess (**L**)/palaeosoil (**Ps**) doublets are present within the "Cuza Vodă" Section, as in the "Costineşti" Section case. The obtained informative palaeomagnetic data (Rădan *et al*., 1990) have shown a **ChRM** with a normal polarity, the analysed profile confirming the calibration of the **L**/**Ps** sequence to the *Brunhes Chron*, which argues an age of the loess and palaeosoil deposits younger than 781 ka.

c) "**Cernavodă**" **Section** (**Cv**; location in Fig. 1C). This section was situated in a flank of the Bogdaproste Hill (SE of Cernavodă), constituted of loess only (ca 20 m thick), which is uniform on the whole profile, without displaying soil processes (Fig. 4).

The "Cernavodă" Section was illustrative for the features of rather young loess of South Dobrogea. The deposits, pointing out a great sedimentation rate, might have been formed in the upper part of the last glaciation (Ghenea, in Rădan *et al*., 1984).

The results obtained for the *Natural Remanent Magnetisation* (**NRM**) intensity and *Magnetic Susceptibility* (**k**) have indicated values lower than 25 mA/m, and lower than $50\times4\pi\times10^{-6}$ SI, respectively (Fig. 4). These features of the magnetic parameters measured before demagnetising the samples are comparable with those characterising the loess horizons investigated in other sections of South Dobrogea. Anyway, the polarity of the Characteristic Remanent Magnetisation (**ChRM**), isolated after the thermal cleaning was applied to the samples, is normal. It is correlated with the *Brunhes Chron* (Fig. 4), particularly with its upper part, taking into account the assignment of these loess deposits to the upper part of the last glaciation.

We add to these results, some “hot” data published by Fitzimmons & Hambach (2013) relating to a loess deposit at Urluia (**Ur**; location in Fig. 1C), placed also in Dobrogea, southwards of the "Cernavodă" Section (Fig. 1C). The loess accumulation at this site is well constrained by a tephra deposit corresponding to the ca 39 ka Campanian Ignimbrite (Fitzimmons & Hambach, 2013). The methods used were the fine-grained quartz optically stimulated luminescence (OSL) dating and environmental magnetism. A mean age of 21.6 ka ± 1.5 ka was determined. The authors point out that the rapid accumulation of loess during the last glacial maximum (LGM) at Urluia is consistent with the increased sedimentation at other loess profiles in the Lower Danube basin. Just above, discussing the "Cernavodă Section" – a location close of Urluia profile – it was revealed a great sedimentation rate for the loess deposits having a thickness of about 20 m (assigned to the upper part of the last glaciation).

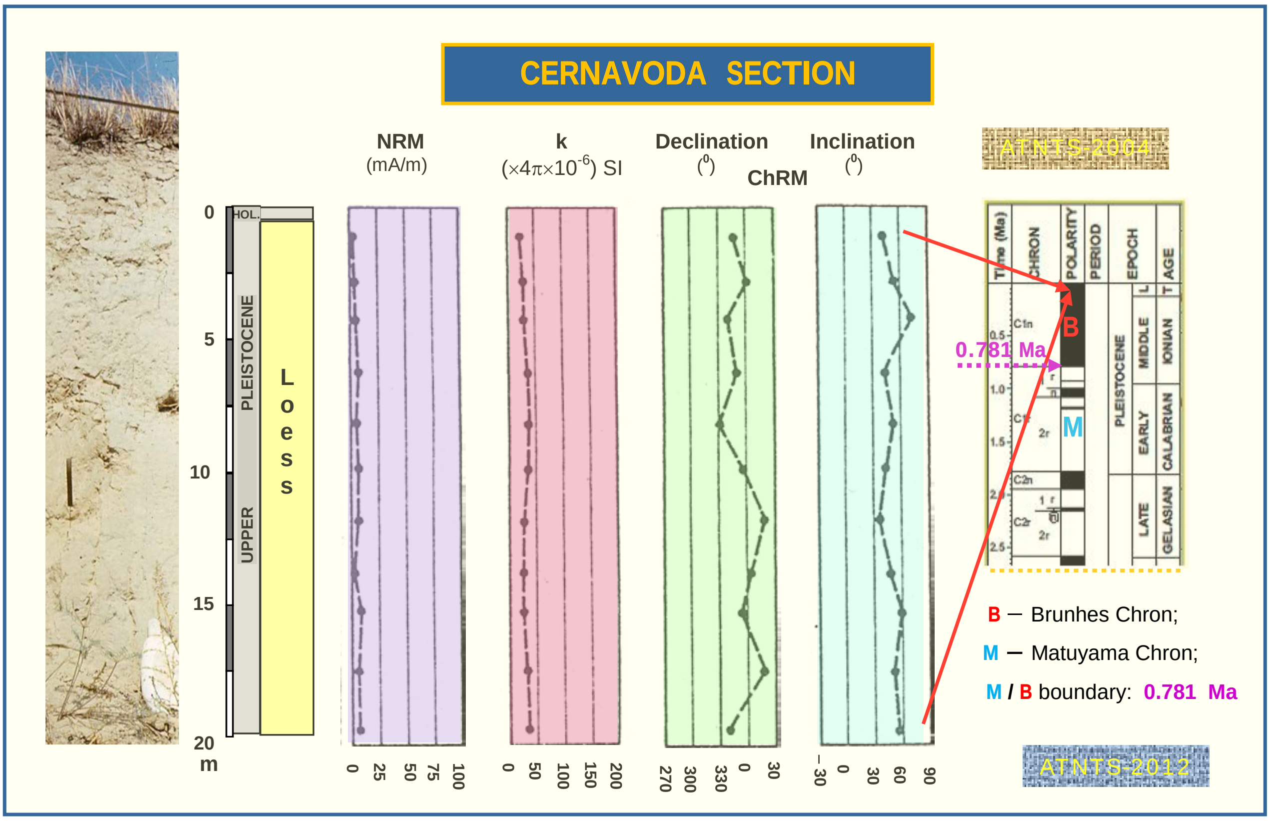


Fig. 4. (Palaeo)magnetic parameters characterising the loess sequence investigated at Cernavodă (Dobrogea, Bogdaproste Hill). Data after Rădan *et al.* (1984, 1990), with some modifications and addings. *Legend*: the same as in Fig. 2. *Photo*: The upper part of the Cernavodă Section (so, the loess sequence from the photo is not at the same scale with the lithological column from the palaeomagnetic model).

Finally, we mention two more sites where loess deposits only were palaeomagnetically investigated, namely "**Popina Isle**" (**PIs**; location in Fig. 1C), in the northern *Razelm* (*Razim*) *Lake*, and "**Jurilovca**" (**Jv**; location in Fig. 1C), on the northern border of the *Goloviţa Lake* (see Table 1). The palaeomagnetic results have shown a normal polarity of the Characteristic Remanent Magnetisation (**ChRM**) identified in the loess deposits, assigning their calibration to the *Brunhes Chron.*

With regard to these loess deposits investigated in locations where palaeosoil horizons have not been found, we cite a new paper (Jipa, 2013), extremely important for understanding the sedimentogenetic processes of the loess accumulation in the Romanian Plain and Dobrogea (see also Ch. 1). Speaking about the "main facies features" of the Lower Danube loess deposits, the author remarks the existence of "*important loess sections located close to the Danube River which show no paleosoil intercalations*".

2.3.2. Romanian Plain

We go on with presentation of sites with loess deposits only, which were investigated for their dating, and we move towards west, in the other area under attention, *i.e.* the Romanian Plain. Among the four locations marked in this area (Fig. 1C), in its western extremity is located the "**Drănic**"

Section (**Dn**), and in its southern extremity, the "**Zimnicea**" profile (**Zm**, in Fig. 1C). To these two places are further referred short comments regarding their magnetostratigraphic approach.

a) Drănic Section (Dn; location in Fig. 1C**)**. The palaeomagnetic/rock-magnetic investigation of the loess deposits situated in the top part of the composite section (Fig. 5) was carried out within a magnetostratigraphic approach of the Pliocene (Romanian) formations which very well crop out in the Jiu - Desnăţui area. This research was performed at the invitation of dr. P. Enciu, who was present during the sampling works (in 1989) and provided the needed information concerning all the the geological aspects related to the field activity. Actually, such data from the Drănic area were then published in detail (Enciu & Andreescu, 1990; Enciu, 2007).

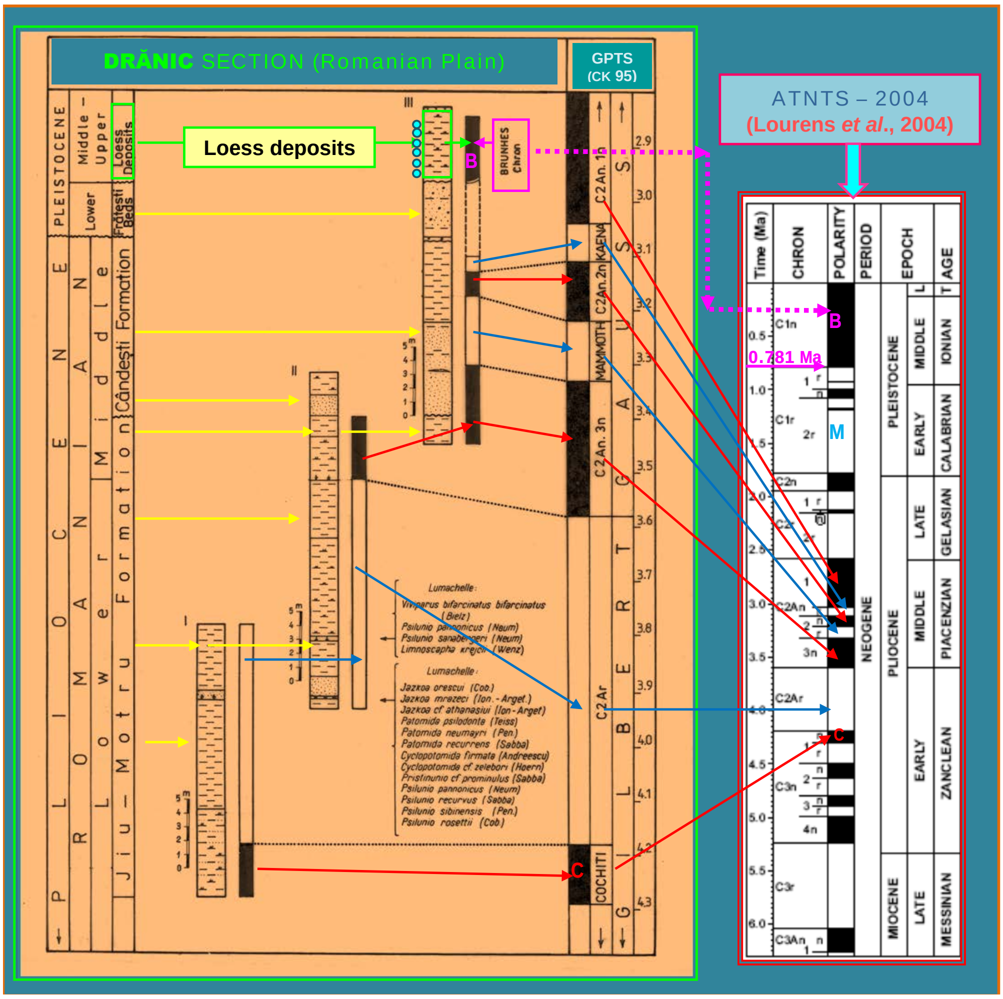


Fig. 5. Magnetostratigraphic model related to the "Drănic Section" (western Romanian Plain), based on the palaeogeomagnetic polarity sequences identified within the magnetic recording medium constituted by Romanian and Pleistocene formations. *Note* 1: The first calibration of the magnetic polarity column was carried out to the Geomagnetic Polarity Time Scale (GPTS) of Cande & Kent (1995) [*i.e.*, GPTS (CK95), in the right side of the initial model; Rădan & Rădan, 1989, in Ţicleanu *et al*. 1989, unpublished report, Geological Institute of Romania; Rădan & Rădan, 1998]. In the updated magnetostratigraphic model is illustrated the correlation to the Astronomically Tuning Neogene Time Scale of Lourens *et al*. (2004) (*i.e.*, ATNTS-2004, in the right extremity of the figure). *Note 2*: The position of the loess deposits (of Middle – Upper Pleisocene age) is distinctly marked in the top part of the subsection III. The lithostratigraphic units, the lithological columns (I,II, III) and the biostratigraphic data are according to Enciu (1989, in Ţicleanu *et al*. 1989) and Enciu & Andreescu (1990). *Legend*: ○ Sampling point within the Loess Formation. **B** – Brunhes Chron; **M** – Matuyama Chron (in ATNTS-2004). **M** / **B** boundary: 0.781 Ma (according to ATNTS-2004, as well as to ATNTS-2012 of Hilgen *et al*., 2012); **C** – Cochiti Subchron (4.300 – 4.187 Ma; ATNTS-2004). *Note 3*: During the field trip, including palaeomagnetic sampling, P. Enciu was present, too.

The magnetostratigraphic position of the "**Drănic**" section, particularly of the loess deposits from the top, integrated within the composite model with the correlation of the Upper Pliocene coal bearing formations from several sections in the western Dacic Basin, is illustrated in the synoptic model from Fig. 6. The correlation was carried out at the level of the *Cochiti Subchron* (*Gilbert Chron*; GPTS-CK95 / ATNTS-2004). Related to the "**Drănic**" composite Section, the *Cochiti Subchron* was detected in the basal part of the "*Drănic III*" *sub-section*, while in the top of the "*Drănic I*" sub-section, the *Brunhes Chron* was identified within the loess deposits (see also Fig. 5).

b) "**Zimnicea**" **Borehole Profile** (**Zm**; location in Fig. 1C). The loess - palaeosoil sequence (Fig. 7) was first investigated in 1999/2000 (Rădan, 2000, in Enciu *et al*., 2000; GIR scientific report, unpublished data). The updated results have recently been published (Rădan, 2012).

The anisotropy of magnetic susceptibility technique, applied for a small set of cubic specimens resulted from the semi-oriented cores (collected by dr. P. Enciu; Rădan, 2000, in Enciu *et al*., 2000), which were intended for palaeomagnetic investigation, has indicated, in general, a depositional/primary magnetic fabric, which is characteristic for undisturbed sediments. Thus, the "*magnetic recording medium*", represented by the loess - palaeosoil couplets, was tested and proved (the small profile fragment at least) to be suitable for (palaeo)magnetic studies.

The model with the magnetic susceptibility variations with depth recorded along the borehole F3-Zimnicea (up to m39), and with the vertical distribution of the **ChRM** inclinations determined for the m25.1 - m29.7 depth interval is illustrated in Fig. 7.

For the first time, a possible interception of the *Matuyama / Brunhes boundary* (*MBB*) within the Romanian loess could be remarked (Fig. 7). Moreover, a very interesting correlation with the "*Lingtai section*" from the central *Chinese Loess Plateau* and with the detailed data of Spassov (2002) and of other authors is pointed out (Rădan, 2012). This concerns the characteristics of the *MBB* location in the loess - palaeosoil sequences (*i.e*., "observed" and "corrected"/"true" *MBB*).

The possibly "*observed Matuyama / Brunhes boundary (MBB)*" is considered to be found within the loess **L8** (Fig. 7), and because of the "lock-in depth mechanism" taking place in sedimentary rocks, "resulting in an offset between the records and the true positions of magnetic reversals" (*e.g*., Horng *et al*., 2002), the "*corrected MBB*" is supposed to be located within the palaeosol **S7**, corresponding to the *marine oxygen isotope stage 19.* This confirms what is postulated in the literature with regard to the correspondence of the Chinese palaeosoil **S7** to the *MIS 19*, and with the delayed Matuyama - Brunhes boundary ("corrected/true *MBB*"), respectively. Moreover, a possible palaeosol ***S8*** (?), located towards the Zimnicea borehole profile base (Fig. 7), could be calibrated to *MIS 21*, which means an age within the interval 0.801 – 0.861 Ma (Spassov, 2002).

More details are presented in a recently published paper (Rădan, 2012).

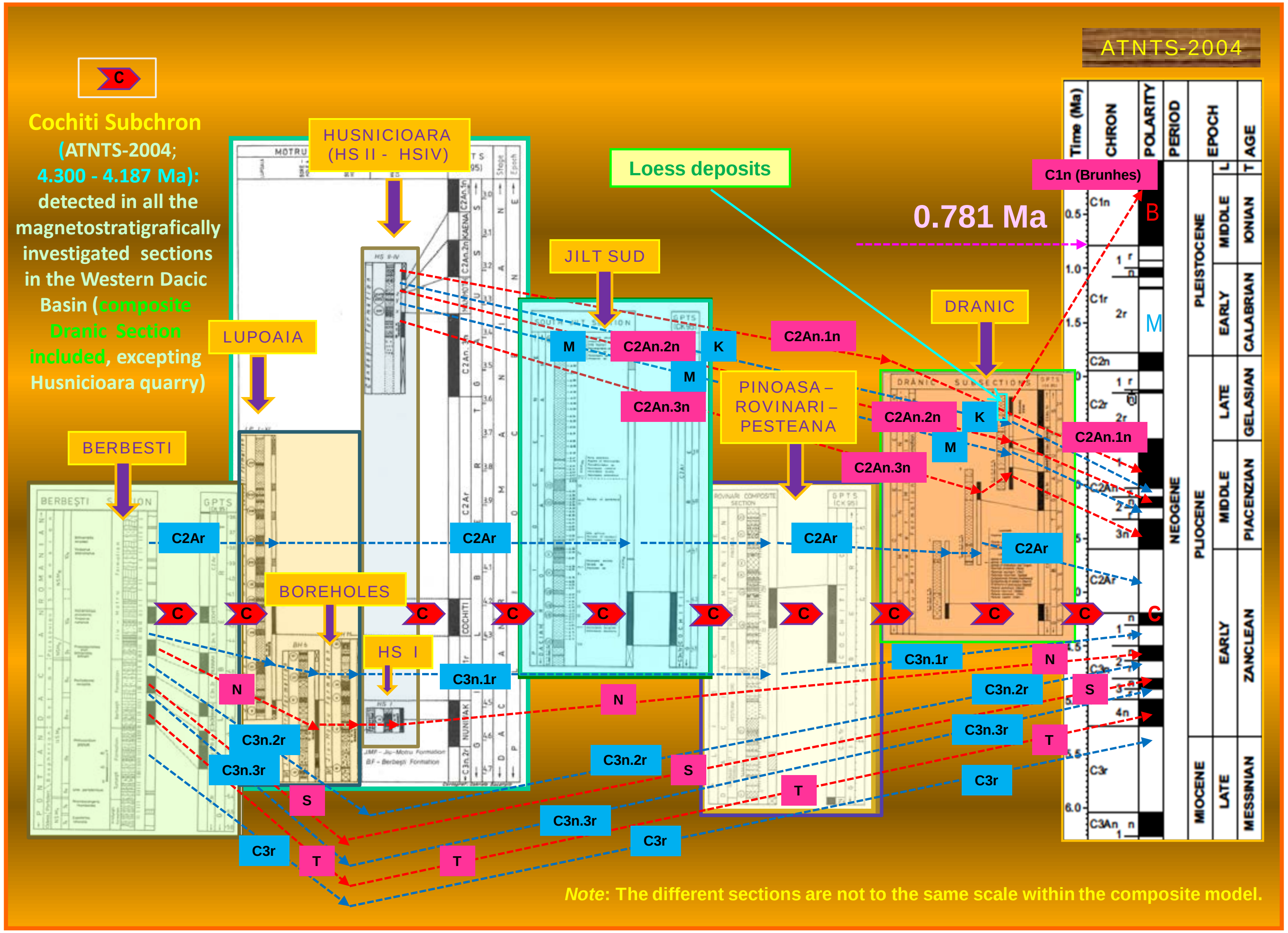
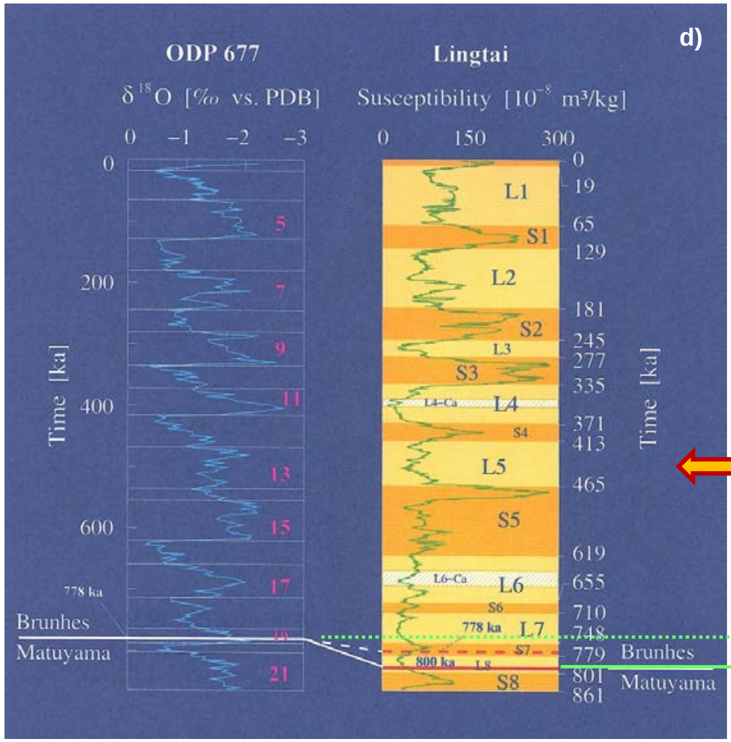
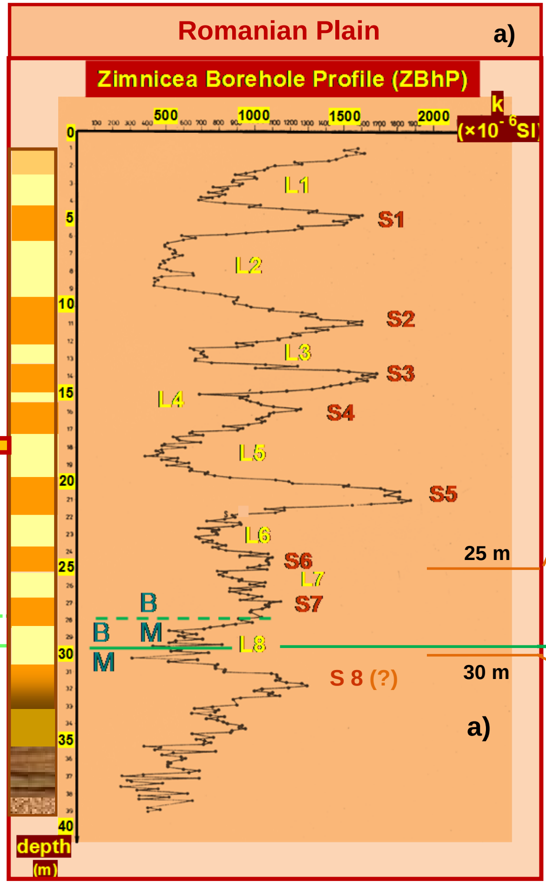
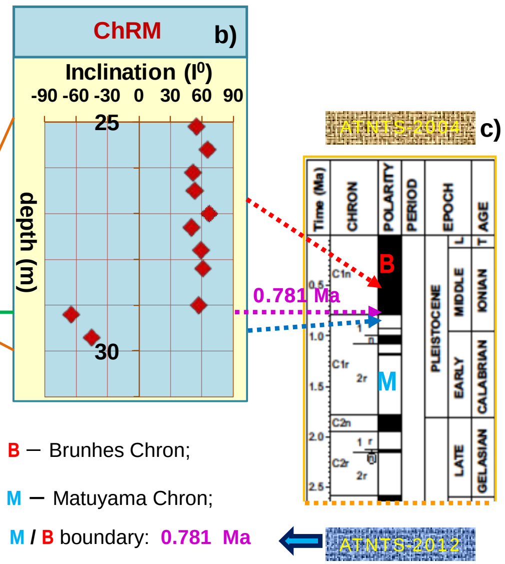


Fig. 6. Synoptic model illustrating the magnetostratigraphic position of the Drănic section (particularly the Loess Formation from the top), integrated within the composite model with the correlation of the Upper Pliocene coal bearing formations from several sections in the western Dacic Basin, at the level of the Cochiti Subchron (Gilbert Chron; GPTS-CK95 / ATNTS-2004). Related to the composite Drănic Section, the Cochiti Subchron was detected in the basal part of the Drănic III sub-section, while in the top of the Drănic I sub-section the Brunhes Chron was identified within the loess deposits (see also Fig. 5).

a) Variations of the magnetic susceptibility (k) with depth recorded for the loess - palaeosol sequence traversed by the Zimnicea (F3) geological borehole. *Legend*: L – loess horizon; S – palaeosol horizon. The green solid line in L8 is the "observed Matuyama (M) / Brunhes (B) boundary" (MBB), as resulted from the palaeomagnetic data, and the bright green solid line shows the correlation with the "observed MBB" in L8 of Lingtai section (CLP), according to Spassov (2002). The green dashed line represents the "corrected/true MBB", located in S7, taking into account the delayed remanent magnetisation, whilst the dashed bright green line shows the correlation with the MBB located at the MIS 19 level in the marine oxygen isotope δ18O record at the ODP site 677 (Shackleton *et al*., 1990); b) Variation with depth of the inclination of the Characteristic Remanent Magnetization (ChRM), after thermal cleaning, for a fragment of the Zimnicea borehole loess - palaeosol profile (between 25m - 30m depth); c) A fragment from the Pliocene – Pleistocene Geomagnetic Time Scale (ATNTS 2004; Lourens *et al*., 2004). MBB – the same age (*i.e.*, 0.781 Ma), in ATNTS 2012 (Hilgen *et al*., 2012).







d) Correlation between the marine oxygen isotope δ18O record at the ODP site 677 and the magnetic susceptibility variations with depth for the loess - palaeosol sequence (a fragment) at Lingtai (CLP). The red solid line in L8 is the "observed MBB", whilst the dashed red line in S7 represents the "corrected MBB". The age of the MBB is 778 ka according to Tauxe *et al.* (1996), cited by Spassov (2002) (figure reproduced from Spassov, 2002). *Note*: The MBB is located at 781 ka, according to ATNTS 2004 / ATNTS 2012.

Fig. 7. Composite model showing a tentative correlation of the integrated magnetic susceptibility and palaeomagnetic signatures recovered from the Zimnicea borehole profile* (Romanian Plain) with the Lingtai section from the Chinese Loess Plateau (CLP) (Spassov, 2002), the marine oxygen isotope δ18O record at the ODP site 677 (Shackleton *et al.*, 1990), and a fragment from the Pliocene – Pleistocene Geomagnetic Time Scale (ATNTS 2004; Lourens *et al.*, 2004).

**Note*: The powder samples and the semi-oriented (up/down) cubic specimens were collected by dr. Petru Enciu and provided to the Laboratory of Rock-, Palaeo-, and Environmental Magnetism of the Geological Institute of Romania [Enciu, P., Berindei, F., Rădan S.C., Wanek, F.W. (2000) – Analysis of the deep aquiferous systems from Romania, Phase Report, *Archives of the Geological Institute of Romania*, Bucharest (unpublished scientific report; *in Romanian*)].

2.4. Some conclusive comments. The Romanian loess in European and Asiatic context

The magnetic susceptibility variations related to the loess-palaeosoil couplets in the sections of the Romanian Plain and Dobrogea – as Hambach *et al.* (2008) stated for the Chinese loess – "*resemble the pattern of the global ice volume record with higher values in palaeosols (interglacials) and lower values in loess (glacials)*".

Magnetic susceptibility is a reliable proxy for palaeoclimate variations in the studied sections, with higher magnetic susceptibility values recorded in the palaeosoil horizons, reflecting warm climate conditions, and lower magnetic susceptibilities in the overlying and the underlying loess horizons, indicating cold periods.

Generally, regarding the loess, the Natural Remanent Magnetisation (**NRM**) intensity and the Magnetic Susceptibility (**k**) are lower than 25 mA/m, and $50\times4\pi\times10^{-6}$ SI, respectively, while concerning the palaeosoils – *e.g.*, in the case of brown-reddish ones –, the values can reach 75 – 100 mA/m, and $150\times4\pi\times10^{-6}$ – $200\times4\pi\times10^{-6}$ SI, respectively (Rădan, 1998; see also Fig. 7, for the magnetic susceptibility).

In the Romanian sections, as in all the profiles in the world, each major palaeosoil horizon can be correlated with an odd numbered oxygen isotope stage, representing a warm and humid interglacial period, while each major loess horizon is correlated with an even numbered *MIS*, representing a cool and dry glacial period. Thus, the magnetic susceptibility signatures recovered from the Pleistocene loess - palaeosoil sequences in the two southern Romania areas can serve as a relative dating tool by using the benthic oxygen isotope record from ODP Site 677 (Shackleton *et al*., 1990). A series of results are inserted in Table 1.

Till now, the biggest number of alternations **L**/**Ps (S)** have been found at Zimnicea (*Romanian Plain* - southernmost point), within a borehole profile (**L1** to **L8**, and **S1** to **S7**, possibly **S8**?) (Rădan, 2012, and some references therein), at Tuzla section (*Dobrogea*/close to the Black Sea shore), *i.e.* 7 doublets (**L1** to **L7**, and **S1** to **S7**) (Bălescu *et al*., 2003), and also 7 couples, after some authors, at Mircea Vodă section (Rădan *et al*., 1990; Rădan & Rădan, 1984a, in Ghenea *et al*., 1984; Rădan *et al*., 1990). Based on 31 studied loess - palaeosoil profiles in Dobrogea, Conea (1970) remarks the "*formations of the soil group 7 are better preserved along the Danube River in both number and thickness*".

In certain synthesis/review papers, written by foreign and Romanian authors, some loess - palaeosoil sections from Romania were integrated within a series of complex patterns to be correlated with profiles from Bulgaria, Serbia, Croatia and Hungary. All these have also been compared with reference profiles from the Chinese Loess Plateau (CLP). Magnetic susceptibility records and magnetostratigraphic data were used in this respect and the correlation with the astronomically tuned benthic oxygen isotope record from ODP site 677 (Shackleton *et al*.,1990) and with the stacked normalized magnetic susceptibility curves recorded for CLP sections (*e.g*., at Lingtai) was carried out.

Comparisons with the results published for the Chinese loess are very stimulating. Yet, a series of important aspects regarding some details of the loess dating by magnetic methods and the correlation with the marine record (oxygen isotope stages) are still disputed between the Chinese researchers (see Rădan, 2012).

In conclusion, not forgeting the existent dispute on the reason of a disagreement between marine and loess records with regard to the *MBB* location (the ”lock-in depth" magnetisation mechanism), we consider as a tentative interpretation, based on the data enclosed in the comprehensive Table 1, too, that the **L1** to **L8** are correlated with *MIS 4* to *MIS 20* (succession of even numbered ”*oxygen isotope stages*“/*OIS*), and **S1** to **S7** are calibrated to *MIS 5* to *MIS 19* (odd numbered *OIS*), spaning a time period of ca 800 ka. Consequently, according to the Zimnicea borehole profile labelling (it seems to be the most complete sequence palaeomagnetically investigated in Romania), the loess - palaeosoil couples **L1**/**S1** to **L7**/**S7** (possibly, the middle - upper part of **S7**) are of Middle Pleistocene - Upper Pleistocene age, while the **L8** (and possibly, the lower part of **S7**) are of Lower Pleistocene age. The arguments are based on the fact that the delayed Matuyama / Brunhes boundary (*MBB*) – because of the so-called ”lock-in depth mechanism“ – is downwards shifted in the “loess - palaeosoil column”, so that while the “*observed MBB*” was found within the loess **L8**, the ”*corrected*/*true MBB*“ should be placed within the lower part of palaeosoil **S7** (the *MBB* is dated – according to ATNTS2004 / ATNTS2012 – at

781 ka). In this context, it is worth to mention Conea (1970), who – based on the ”classic stratigraphy“ studies – assigns the group of soils **GS7**, identified in some sections from Dobrogea, to the ”*Günz-Mindel Interglacial and to older phases of the Lower Pleistocene*” (see Table 1).

At the end of this short overview on the Romanian loess dating over the last half-century (see Table 1), and adding the significant sedimentary features of the loess accumulation revealed by Dr. D.C. Jipa in the previous chapter (and also, Jipa, 2013), we can accept that the loess approach is a complex undertaking, and we can confirm the both statements: ”*Loess is not just the accumulation of dust*“ (Pecsi, 1990) or ”*Loess is not just accumulated dust*“ (Buggle *et al*., 2012). Therefore, the loess - palaeosoil sequences are relevant for geosciences, they are Quaternary archives for palaeoenvironmental reconstruction, and as Hambach *et al*. (2012) consider, they are ”*some of the most detailed and long-term terrestrial records of Pleistocene climate change*“.

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3. THE DANUBE DELTA: GEOLOGY, SEDIMENTOLOGY AND GEOECOLOGY

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3.1. Geomorphology of the Danube Delta

The River Danube is one of the most important European waterways, flowing 2,857 km across the continent from the Schwarzwald Massif down to the Black Sea. The Danube is listed after the River Volga as the second biggest river in Europe. Its drainage basin extends on 817,000 Km$^{2;}$ more than 15 countries share the Danube catchment area and about 76 million people live within this area.

The Danube Delta is situated in the north-western part of the Black Sea, between 44°25' and 45°30' northern latitude and between 28°45' and 29°46' eastern longitude, being bordered by the Bugeac Plateau to the North and by the Dobrogea orogenic area to the South (Fig. 1). The Delta represents one of the main elements of the Geosystem River Danube - its delta - Black Sea. The Danube Delta can be divided into three major depositional systems (Panin, 1989): the *delta plain*, the *delta front* and the *prodelta* (Fig. 2). To these is to be added the Danube deep-sea fan placed beyond the shelf break reaching from several hundred meters water depth down to the abyssal plain (just over 2,200 m).

Fig. 1 – The Danube Delta – Landsat image.

The three major depositional systems of the Danube Delta are characterised as follows: the *delta plain*, with a total area of about 5,800 Km^2, from which *the marine delta plain* area is of 1,800 km^2; the *delta front* with an area ca. 1,300 km^2, divided into *delta front platform* (800 km^2) and *delta-front slope* (ca. 500 km^2), extending off-shore to a water depth of 30-40 m; the *prodelta* lies off-shore at the base of the delta-front slope to 50-60 m depth, covering an area of more than 5,500 - 6,000 km^2.

The ***delta plain*** starts from the first bifurcation of the Danube (the delta apex), called Ceatal Izmail; here the river divides into two distributaries: a northern one – *Kilia*, and a southern one – *Tulcea*.

The *Kilia distributary*, the most important of the delta system (ca. 62-63% of the total water discharge of the Danube and ca. 65% of the sediment discharge in 70's, with a tendency of diminishing – only ca. 52% nowadays), is 117 km long and forms a lobate delta with numerous distributaries (the main ones are Oceakov, flowing to NE and Stary Stambul, oriented towards S-SE); this secondary delta has an area of 24 400 ha and lies within Ukrainian territory.

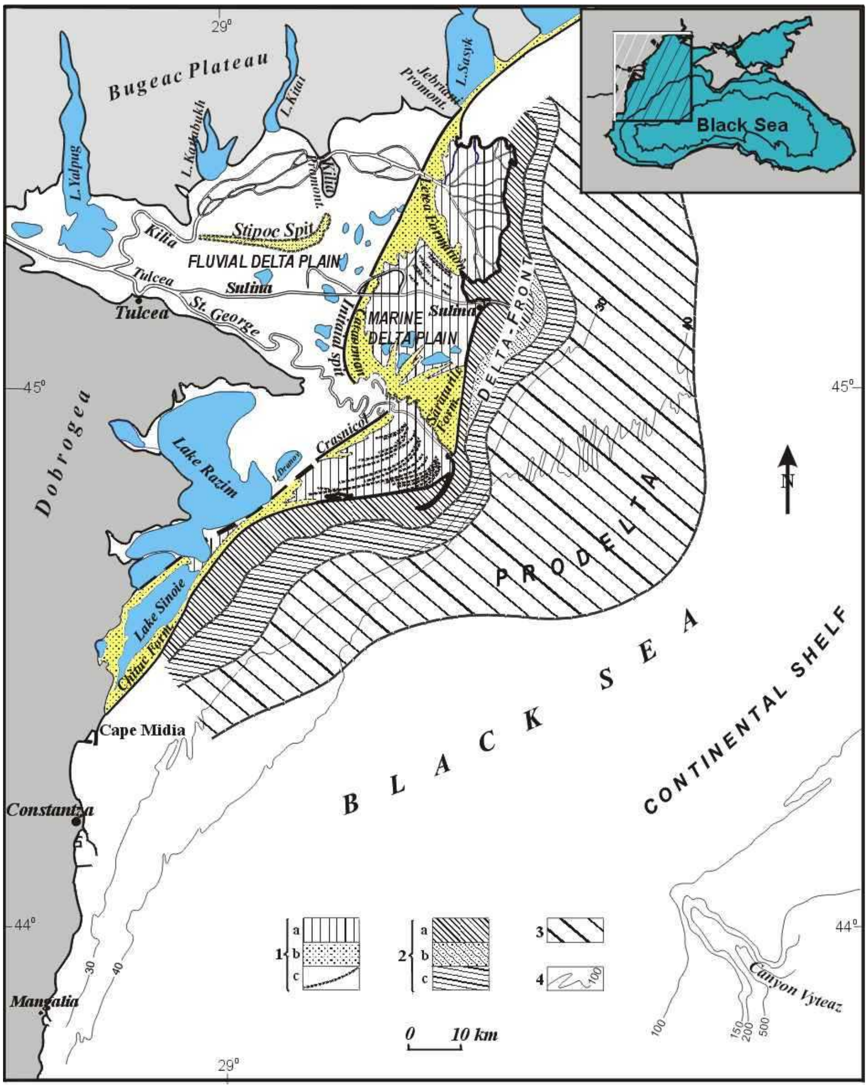

Fig. 2 – The Danube Delta Major morphological and depositional units (after Panin, 1989).
Legend: 1. Delta Plain: a) Fluvial Delta Plain; b) Marine Delta Plain; c) Fossil and modern beach-ridges and littoral accumulative formations built up by juxtaposition of beach ridges;
2. Delta Front: a) Delta Front platform; b) relics of the Sulina Delta and its Delta Front;
c) Delta Front slope; 3. Delta Prodelta; 4. Continental shelf area; 5. Depth contour lines.

The *Tulcea distributary* flows along 17 km between Ceatal Izmail and Ceatal Sf. Gheorghe, where it divides into two other branches: Sulina on the left and Sf. Gheorghe (St. George) on the right.

From the Ceatal Sf. Gheorghe, the *Sulina distributary* stretches eastward 63.7 km (or 71.7 km, including the 8 km of dykes at the mouth of the arm) towards the Black Sea. Sulina distributary was originally 83.8 km long, but in the 1868-1902 period it was rectified for sea navigation by the European Danube Commission, by cutting off its meander loops. Its water discharge, very low before meander loops cut-off (7-9%), represents today about ca. 20% of the total Danube discharge.

The *Sf. Gheorghe (St. George) distributary* is 108.8 km long and it takes over ca. 21-22% of the total water discharge and approximately 20% of the sediment discharge of the Danube before 80's. During the period 1985-1988 all the meanders have been rectified; these meander cut-offs lead to a shortening of the distributary by about 31 km and, consequently, increased the free water surface slope and water flow velocity. As a result, the water and sediment discharges started to increase (up to ca. 28% of water discharge) (Bondar and Panin, 2002). At its mouth a small secondary delta, which fork at km 5, is formed: the prolongation of the main Sf. Gheorghe channel (also called in historical documents *Kedrilles*) and the *Olinca branch* on the right. This latter branch bifurcates to two small distributaries: the *Seredne* on the left (about 3.5 km long) and *Gârla Turcului* on the right (4.5 km in length).

The present-day morphology of the Danube Delta evinces the Jibrieni-Letea-Răducu-Ceamurlia-Caraorman line which marks the boundary between the *upper* or *"fluvial delta plain"* to the west and the *lower, "marine delta plain"* to the east. In the marine delta plain there are numerous beach ridges, which in certain zones generate, by juxtaposition, accumulative littoral formations (among which the most important are: *Jibrieni* – on Ukraine territory, *Letea, Caraorman, Sărăturile, Perişor, Chituc* etc). In the fluvial delta plain one notes fluvial levees, meander-belt bodies, interdistributary depressions with their hydrographic network and a particular feature, the *Stipoc lacustrine spit*.

The ***delta front*** area can be divided into the *delta front platform* and the *delta front slope* (Fig. 2). The main delta distributaries debouche into zones with different bathymetry: in the North, the Kilia distributary flows into a continental shelf area of 20-25 m depth, while in the South, at the mouth of the Sf. Gheorghe distributary, the water depth is considerably higher: 30-40 m. This differentiates the morphology of the delta front in the two mentioned areas.

The *Kilia delta front platform*, slightly sloping (0.002-0.004) extends on 1.5-2.5 km to the isobaths of 5-7 m, where from the delta front slope prolongs off-shore as far as to about 15 m depth in the North and 20 m in the South.

The *delta front of Sf. Gheorghe branch* consists of a platform containing the main distributary mouth bar, the arcuated lateral littoral bar named *"Sakhalin Island"*, the mouth bars of the Turcu and Seredne secondary distributaries and the area behind the Sakhalin Island. The platform reaches the water depth of 12-15 m, sloping at 0.003-0.005. The delta front slope, with dips of 0.008-0.01, extends offshore to a water depth of 35-40 m.

A singular case is noted in front of *Sulina distributary*. In the Sărăturile-Împuţita sector of the coastal zone, the *delta platform* is less marked and the bottom slopes to the depth of 12-15 m, with a steepness of 0.006-0.008. In front of the Sulina distributary mouth and southward to the parallel of the Lake Roşu, remnants of Sulina Delta and its front are present (the Sulina Delta has been eroded, as further shown, during the last about 2,500 years). Therefore, in the bathymetric interval of 10-20 m the slope is of 0.001-0.003, following offshore the old front of Sulina Delta to 30-35 m depth with a slope of 0.003-0.006.

The ***prodelta*** lies off-shore, at the base of the delta front to 50-60 m depth. The outer eastern boundary of the prodelta in front of the main delta distributaries can be accurately identified (Fig. 2). On the contrary, the southern boundary is more difficult to define on account of the strong southward drift of fine grained sediment load discharged into the sea by the Danube, which is stumping the prodelta limit. The influence of this material is felt all over the continental shelf even south of Constanţa.

The delta front and especially the prodelta displays a pattern of elongated depressions, swales, resembling some small valleys or submarine channels, 4-10 m deep, bordered by lateral levees or ridges (Fig. 2). These channels seem to constitute discharge ways of turbid flow yield by the river distributaries especially at high flood.

Beyond the prodelta, seaward, lies the *"sediment starving continental shelf"* with a thin, non-consolidated, present-day sediment cover. Here we can identify the pattern of the channels followed by the Danube during the low sea level periods towards the shelf edge, more precisely to the canyon Viteaz (Fig. 2).

The mentioned ***Viteaz canyon*** has an average width of 4 km and incisions on the order of 450 m. It is situated approximately along the prolongation of a major, NW-SE – striking fault Peceneaga-Camena in Dobrogea. The sub aerial river-cutting during sea-level lowstands, as well as slumping and related mass wasting process on the continental slope at fault-controlled location are, probably, the main processes which led to the canyon initiation and further development and widening. On the middle shelf, the numerous buried paleo-channels, followed probably by the Danube during the sea lowstand, seem to be directed to the Viteaz canyon head.

The ***Danube deep-sea fan*** is located offshore Romania, Bulgaria and Ukraine in the north-western Black Sea and extends over 150 km both in width (NE-SW direction) and length (NW-SE), reaching from several hundred meters water depth down to the abyssal plain (over 2,200 m). The upper slope is degradational, characterised by rugged, concave-upward surface, and is dissected by the Viteaz and other submarine canyons, as well as channels without levees or with only nascent levees. The aggradational lower slope is dominated by a well-developed channel-levee system and is convex-upward, but its surface is much more regular. Unchannelized flow and turbiditic and hemipelagic sedimentation mark the distal lower slope and the abyssal plain.

3.2. Geologic setting, genesis and Holocene evolution of the Danube Delta

The delta development is controlled by: the Danube sediment input (the average sediment discharge is ca. 40.10^6 t/y, of which $4\text{-}6.10^6$ t/y sandy material); the prevalence of winds from the northern sector (40-50% of instances) of the delta front area; the predominance of southward oriented marine currents; the long shore sediment drift directed also towards the south; the relatively important values of wave power etc. The interaction of these factors determines the delta morphological type, the geometry of the volumes of deltaic deposits, the asymmetry of the deltas of the Danube distributaries and their development and evolution.

The Danube Delta overlaps the Predobrogean Depression, which, in its turn, lies mainly on the Scythian Platform (Fig. 3). The sequence of the Scythian Platform cover deposits, which constitute the fill material of the Pre-Dobrogean Depression, displays six sedimentation cycles: Palaeozoic calcareous–dolomitic; Lower Triassic of considerable thickness (400-2500 m), slightly unconformable over subjacent deposits and consisting of red continental detrital deposits with interlayered volcanic rocks; Middle-Upper Triassic transgressive, marine, built up of carbonate rocks in the lower part (350-450 m limestones, and 500-600 m dolomites) and of detrital rocks (450 m) in the upper part; Jurassic transgressive marine, consisting of detrital deposits at the base (Middle Jurassic, 500-1700 m thick) and carbonate ones at the top (Upper Jurassic, 1000 m thick in the southern area); Lower Cretaceous overlying Jurassic deposits, consisting of red continental deposits of varying thickness (ca. 500 m) and Sarmatian-Pliocene overlying different Mesozoic deposits and consisting of alternating clay, sand and sandstone (200-350 m thick) (Pătruţ *et al.*, 1983).

The Delta is situated in an area of high structural mobility, repeatedly affected by strong subsidence and important sediment accumulation. The deltaic conditions developed here during the Quaternary, when the Danube started flowing into the Black Sea basin.

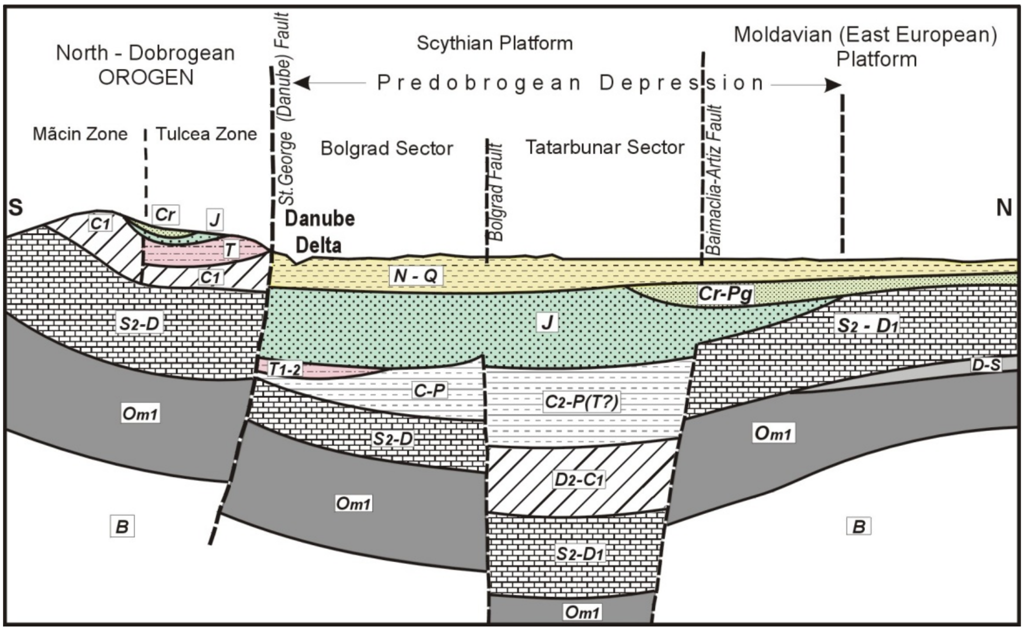

Fig. 3 – Geologic section showing the location of the Danube Delta within the major structural units of the region

Legend: B: Basement; O: Ordovician; S: Silurian; D: Devonian; C: Carboniferous; P: Permian; T: Triasic; J: Jurassic; Cr: Cretaceous; Pg: Paleogene; N: Neogene; Q: Quaternary.

The Delta edifice is built up of a sequence of detrital deposits of tens to 300-400 m thickness formed mainly during the upper Pleistocene (Karangatian, Surojskian, Neoeuxinian) and the Holocene (Fig. 4).

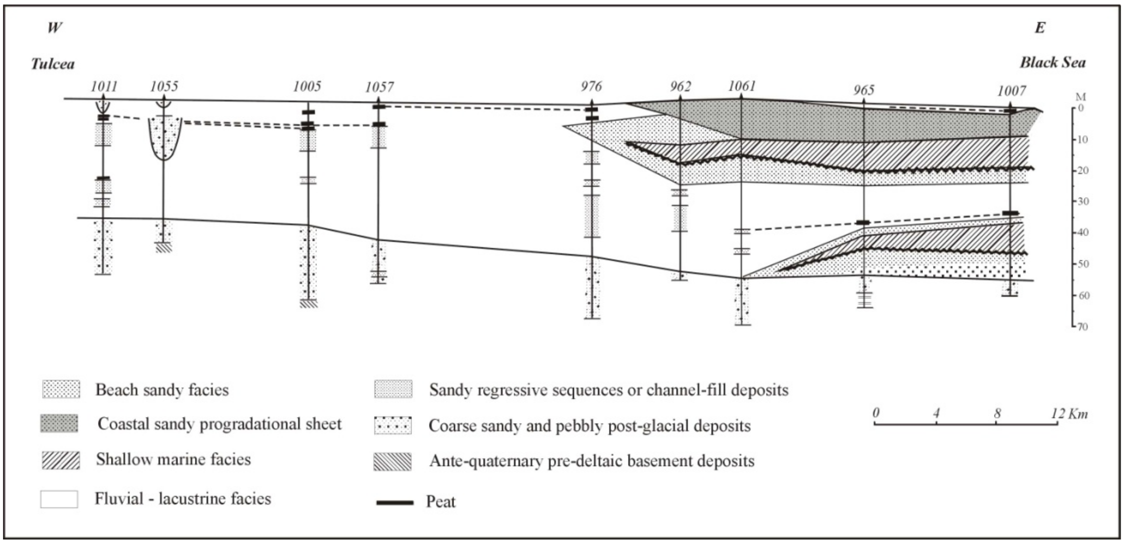

Fig. 4 – Schematic cross section through the Danube Delta

The Holocene evolution of the Danube Delta includes the following main phases: (1) the formation of the Letea-Caraorman initial spit, 11,700-7,500 years BP; (2) the St. George I Delta, 9,000-7,200 years BP; (3) the Sulina Delta, 7,200-2,000 years BP; (4) the St. George II and Kilia Deltas, 2,000 years BP - present; (5) the Cosna-Sinoie Delta, 3,500-1,500 years BP (Fig. 5).

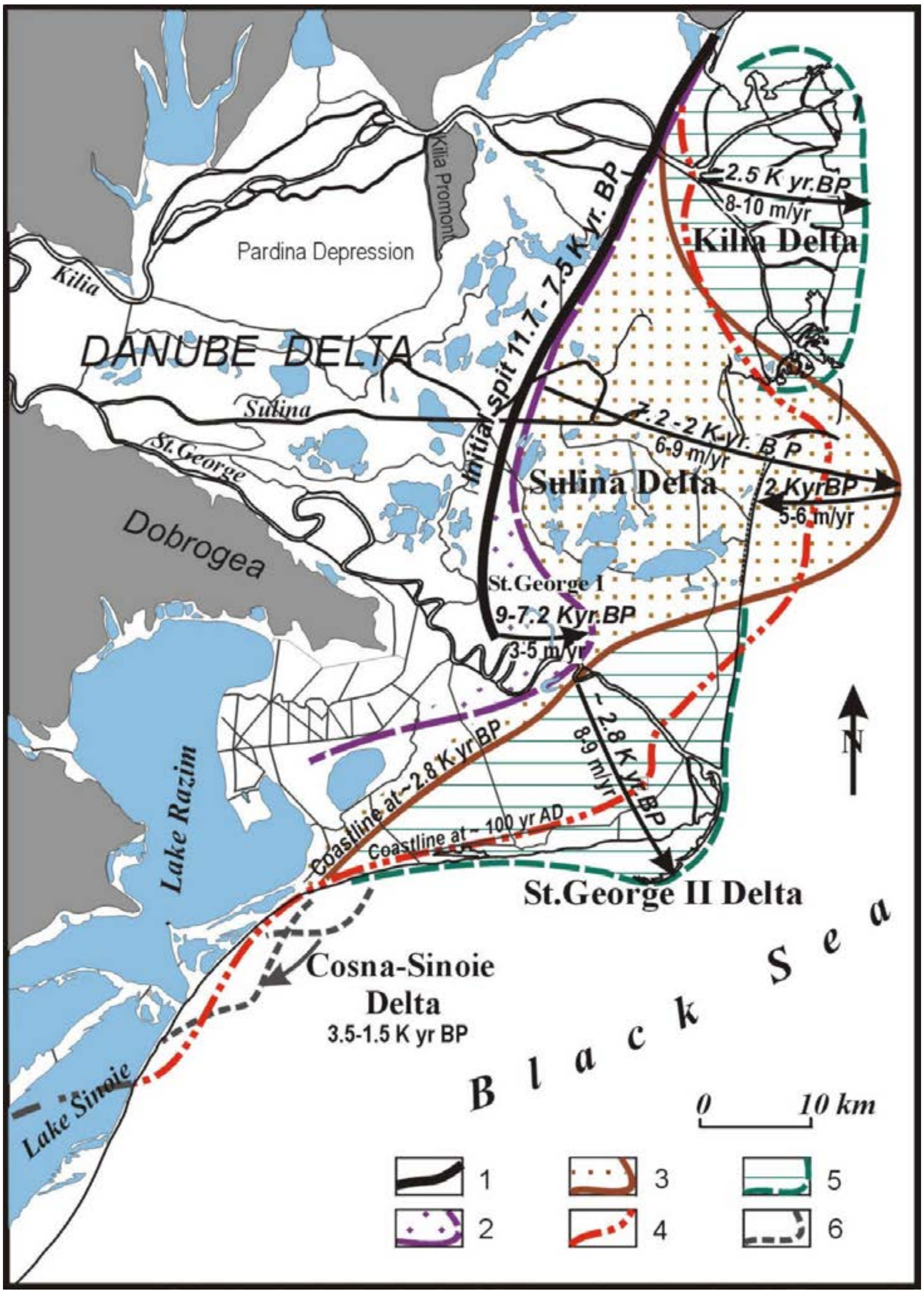

Fig. 5 – The Danube Delta evolution during the Holocene and correspondent coastline position changes (after Panin, 1997)

The Danube Delta plain displays the following main facies of sediments: (I) marine littoral deposits of two types: type **"a",** formed by the longshore drift from the North (from the mouths of rivers Dniester, Southern Bug and Dnieper), and type **"b",** of Danubian origin; (II) lacustrine littoral deposits, forming the Stipoc and Roşca-Suez lacustrine spits; (III) fluvial deposits, genetically related to the Danube distributaries system, include several types: bed-load and mouth-bar deposits, sub-aqueous and sub aerial natural levees deposits, crevasse and crevasse-splay deposits, point bar and meander belts deposits, decantation deposits into intra-deltaic depression and inter-distributary area etc.; (IV) marsh deposits; (V) loess-like deposits (Fig. 6).

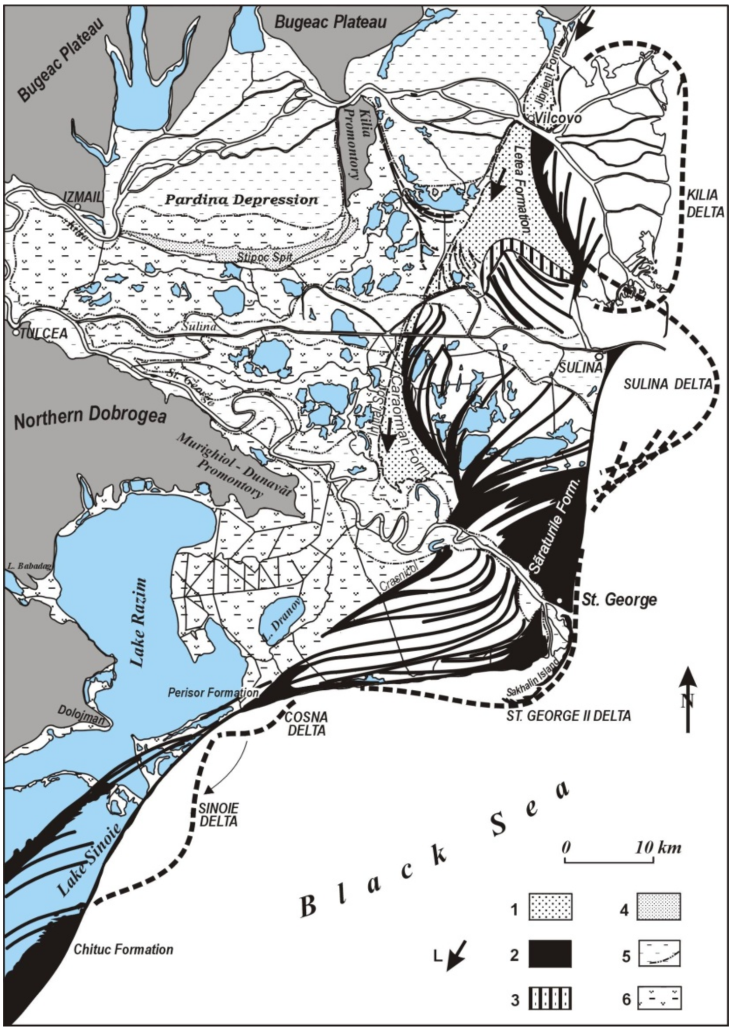

Fig. 6 – Areal distribution of the main types of deposits within the Danube Delta territory (after Panin 1989).

1: marine littoral deposits of type "a", formed by the littoral drift from the rivers Dniester and Dnieper mouths; 2: marine littoral deposits of type "b", of Danubian origin; 3: deposits of littoral diffusion, formed by mixing of "a" and "b" types; 4: lacustrine littoral deposits; 5: fluvial meander belt deposits; 6: interdistributary depression deposits; L: direction of the longshore sediment drift.

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4. FIELD TRIP IN DOBROGEA AND THE DANUBE DELTA

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4.1. Introduction

The field trip organized in the framework of the 2013 SEQS Meeting is focused on two distinct environments: *continental-aeolian*, represented by Late Quternary loess-paleosoil sequences developed in South Dobrogea area (first day), and *transitional-deltaic*, represented by the Danube Delta and consisting in a very complex and dynamic system of channels, lakes, marshes and paleo-beach ridges; these represent the upper, visible part of a sedimentary edifice formed during Upper Pleistocene and Holocene time (two following days). The *field trip itinerary map* is attached at the end of the Chapter 4 (Fig. 20).

Dobrogea is located in the south-eastern extremity of Romania, covering the area between the Danube (western and northern borders) and the Black Sea (eastern border); the southern part is continuing over the Romanian-Bulgarian border. This area includes three tectonic units – Northern, Central and Southern Dobrogea, showing distinct geological features. The tectonic units are separated by two major crustal faults, approximately oriented NW-SE: Peceneaga-Camena (between North and Central Dobrogea) and Capidava-Ovidiu (between Central and the Southern units). Theese three units will be crossed from South to North during the first day journey.

The basement of the *South Dobrogea unit* is represented by the eastern deeper part of the Moesian Platform, including Archean gneisses, overlain by a Karelian banded iron formation (Giușcă *et al.*, 1967), and a sedimentary cover, consisting of Cretaceous, Tertiary and Quaternary deposits (mainly loess).

The *Central Dobrogea* represents the eastern elevated part of the Moesian Platform, occupying a horst position between the above mentioned faults, and showing a Neoproterozoic folded basement, built up of anchimetamorphic Green Shales (Histria Formation). This formation is croping out on large areas and is partially covered by the Upper Jurassic carbonate platform preserved in so called Casimcea Syncline.

The *North Dobrogea* is a remnant of the European Hercynian Chain. The pre-Triassic basement of this unit contains Paleozoic slate beds, calc-alkaline volcaniclastics and granitoids, Late Triassic – Middle Jurassic deposits (terrigenous turbidites), Upper Jurassic deposits of a carbonate platform and a thick sequence of Upper Cretaceous shelf carbonate-detrital deposits, included in the Babadag Syncline (Seghedi, 2001).

The ***Danube Delta*** is one of the main components of the Danube River system, and represents the natural interface between a vast drainage area (817,000 km^2) and the inland-receiving basin of the Black Sea. The delta is fluvially dominated, and shows a typical triangular shape, having 65 – 85 km distance from apex to coast and up to about 70 km width between the branches. This is the second largest deltaic area in Europe, after the Volga Delta, covering more than 4,150 km^2 of complex watersystems and emerged land belts. There are about 3,500 km of natural streams and artificial canals, connecting more than 450 lakes, all these water bodies representing closely interacting ecosystems. A series of interdistributary depressions, with specific hydrographic network consisting of interrelated systems of lakes and channels, may be outlined between the main Danube branches and south of the Sf. Gheorghe Branch. Two depressions (Sireasa and Pardina) have been wholly transformed in agricultural polders and their watersystems include now only some artificial drainage canals. Southwards, there is the ***Razim – Sinoie Lagoon Complex***, a large lacustrine area (1,015 km^2), supplied with water and sediments from the Sf. Gheorghe Branch. Throughout this group of lakes can be observed a slow general water flow, from north to south, which at last discharges to the Black Sea through the Periboina and Edighiol outlets, located in the southernmost part of the lacustrine complex. The depths of the deltaic and lagoonal lakes don’t exceed usually 3.5 m.

The anthropogenic activities developed within the danubian hydrographic basin, populated by 85 millions inhabitants, made Danube River the most important eutrophication and pollution source, both for the Black Sea and for the Danube Delta. The riverine influence and the human interference carried out inside the Danube Delta itself have disturbed the natural equilibrium of this highly dynamic, but particularly sensitive assemblage of biocoenoses and ecosystems. There are only 15,000 inhabitants in the delta, but more than 300,000 people are living around the Danube Delta and Razim – Sinoie lacustrine complex, exerting an important anthropogenic pressure over the whole deltaic and lagoonal biome.

4.2. First day – 25th of September, 2013

Constanţa – 2 Mai village – Mircea Vodă – Murighiol (by car) – Uzlina (by motorboat)

The road from Constanţa to 2 Mai village is running southwards (about 50 km) along the Black Sea coast, crossing the Danube – Black Sea Canal at Agigea and passing through several resorts – Eforie Nord, Eforie Sud, Techirghiol, Costineşti and Mangalia, the last one representing, also, an important centre of shipbuilding industry of Romania. 2 Mai village is also a holiday resort, situated at 5 km south of Mangalia, with a population of 2,250 inhabitants (2002 census). First stop is located at the southern end of the village (N43°46´35″, E28°34´49″).

Stop 1 – *Loess-paleosoil sequences in the 2 Mai section*

The outcrop consists of a long (hundreds of meters) and high (ca. 15 m) cliff, exposed to the east, along the seaside (Fig. 1). The Quaternary sequence of 2 Mai is overlying Sarmatian limestones (Fig. 2) and shows a quite clear succession of the alternating loess and soil beds (Fig. 3).

Fig. 1 – General view of „2 Mai" loess-paleosoil section

An impressive and wellknown loess-paleosoil exposure was Costineşti section (Fig. 4). We said „it was", because, unfortunately, the outcrop was destroyed in the last few years by the engineering works devoted to the sea shore protection (Fig. 5). There are a lot of studies concerning this site, mentioned in the 1st and the 2nd chapters of this guidebook. The good news is that the two sections, Costineşti and 2 Mai, are quite similar. In both sections, most researchers have identified up to six loess-paleosoil couples (see Rădan & Rădan, 1984 a, b and Ghenea & Rădan, 1993 in the first chapter of the guidebook).

Fig. 2 – Loess-paleosoil sequences overlying Sarmatian limestones at 2 Mai

Fig. 3 – Loess-paleosoil alternances at 2 Mai

Fig. 4 – Costineşti section before the cliff earthworks (after Timar *et al.*, 2009)

Fig. 5 – Costineşti section during the cliff earthworks (2013)

The variation of magnetic susceptibility in the 2 Mai section was studied by Panaiotu (in Dimofte *et al*., 2011), who found 6 loess-paleosoil pairs, but only 5 in Costineşti (Fig. 6).

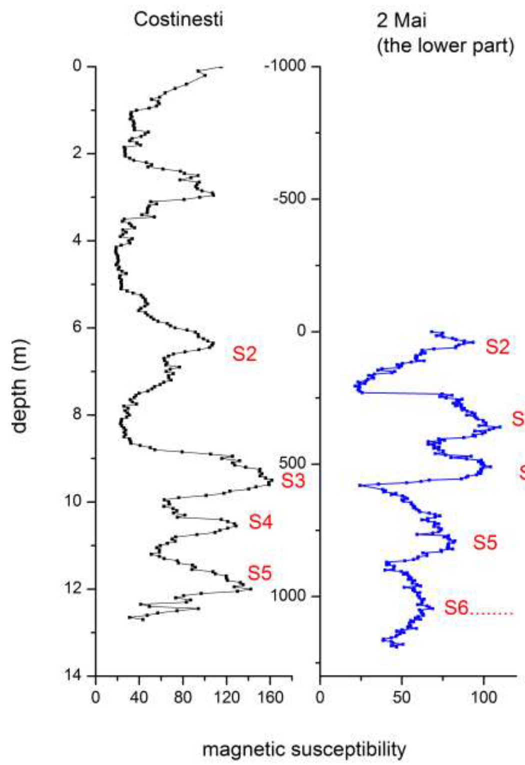

Fig. 6 – Magnetic susceptibility of the loess-paleosoil sequences in Costineşti and 2 Mai (Panaiotu, in Dimofte *et al*., 2011)

Generally, in this area, the upper two paleosoils are of chernozem type, the following two beds are clayey soils, with prismatic structure, and the two lowermost ones are represented by red clays. In the base of the paleosoil 6, the loess can no longer be identified (Ghenea & Rădan, 1993).

From 2 Mai village we will travel back north (about 100 km), to Mircea Vodă. The route is crossing again the Danube - Black Sea Canal at Agigea, from where we follow the A2 motorway west. After about 25 km, we quit the highway, following a secondary road to the north, to Medgidia town. From the Medgidia bridge, where the road is crossing once again the Canal, we can see the Upper Cretaceous chalk deposits of the South Dobrogea unit. After about 10 km west, we arrive in Mircea Vodă village. The stop 2 – the wellknown section of loess-paleosoil of Mircea Voda is located 5 km north of the village (N44°19′18″, E28°11′28″).

Stop 2 – *Loess-paleosoil sequences in the Mircea Vodă section*

The Mircea Vodă section is one of the most impressive loess exposure in Dobrogea, due to the dominant position of the hill where this is situated and to the high cliff formed after landslides caused by the huge Aptian caolinitic clay quarry which has been exploited in the years 60-70s (Figs. 7 and 8).

Fig. 7 – General view of Mircea Vodă loess-paleosoil section
(Caolinitic clay deposits of continental origin are seen in the foreground)

Fig. 8 – Mircea Vodă loess-paleosoil section (partial view)
(Sarmatian limestones are seen in the foreground)

After different authors, 6 to 7 loess-paleosoils can be identified. The loess deposits containing paleosoil interbeds crop out to a lenght of ca. 150 m and a height exceeding 25 m. The loess sequence is overlying Aptian caolinitic clays and Sarmatian limestones (Figs. 7 and 8).

The road from Mircea Vodă to Murighiol is about 150 km long, and crosses the three main tectonic units of Dobrogea. After leaving the South Dobrogea unit at Ovidiu, the route crosses the Central unit (about 60 km), up to Baia locality. Along the road, numerous Green Shale outcrops of the Precambrian Histria Formation and limestone cliffs of the Upper Jurassic Casimcea Syncline can be observed. North of the Baia locality, the route crosses the Peceneaga-Camena fault, and passes to the Northern Dobrogean Orogene area. Upper Cretaceous (Cenomanian, Turonian and Coniacian) of the Babadag Syncline unit, consisting of deposits of the post-tectonic cover, represented by limestones, marlstones and, rarely, by conglomerates and sandstones, are croping out in places. After crossing Taiţa Valley, close to the town of Babadag, up to Murighiol, the route passes over the Triassic calcareous deposits of the Tulcea Nappe (one of the North Orogene sub-unit). Impressing outcrops of fossiliferous limestones occur in the vicinity of Agighiol village. The fossil site from Dealul Pietros presents an exceptional value for the European and international Alpine Triassic, with its rich fauna of ammonoids, bivalves brachiopods and gastropods (Bleahu *et al*., 1976).

From Murighiol, a nice fishermen village, situated on the right bank of the Danube, we leave the land and continue the travel aboard a motorboat, to the laboratory/house-boat “Halmyris” of GeoEcoMar, anchored about 2 km upstream on the most important meander of the St. George branch. The participants will have dinner and spend the night on board.

4.3. Second day – 26th of September, 2013

September is characterized by the lowermost water levels of the Danube River. This fact creates, among other problems, difficulties in navigation along the Danube Delta waterways. For this reason, after breakfast, the participants will be transferred by small motorboats, through Uzlina canal, to the Lake Uzlina. From this place, our route continues on board of the motorboat "Selena", through Isacova Lake, Litcov Canal and Caraorman Canal, to Caraorman village (3rd stop). After visiting the paleo-dune field and the old forest, we leave the village and keep on sailing, following the Caraorman Canal to Sulina branch, then, at the end of the day, we will stop in Sulina (Stop 4), where we will be housed overnight in the "Casa Coral" guesthouse.

Stop 3 – *Caraorman village*

Caraorman means in Turkish the "Black Forest". So, few people know that the River Danube flows from the Black Forest Mountains to the Black Forest Village about 2,700 km downstream. The presence of population on the Caraorman dry land is already mentioned during the Greek and Roman colonisation of the Black Sea coastal zone. In the writings of Ancients is mentioned the Peuce Island at about 120 stadia (about 25 km) from the Hieron Stoma (mouth of St. George distributary).

The village has less than 1,000 inhabitants, mostly of Ukrainian origin (Khakhols). The general impression is given by nice and very clean paint in white and blue or green houses (Fig. 9), with characteristic Danube Delta architecture, broad sandy streets in geometric alignment, three orthodox churches with strong Russian influence, all placed in a very flat sandy landscape.


Fig. 9 – Tipical houses in Caraorman village

In the 80's the communist regime imposed a forced industrialisation of this area. The officials intended to utilise the very clean quartzy sand of Caraorman Formation for metallurgy and glass manufacture. The Caraorman Village port was intended for this exploitation as well as the Caraorman canal was dug for transporting the sand by barges to Galatzi metallurgical plants. Presently, after the political changes in Romania in 1989 and the establishment of the Danube Delta Biosphere Reserve in 1992, the plans of exploiting the Caraorman sands were abandoned, and, consequently, all the buildings and port equipment were also abandoned, showing a really distressing image (Figs. 10 and 11).

Fig. 10 – Abandoned sand preparation plant

Fig. 11 – “Ghost” town of Caraorman

Caraorman littoral accumulative formation

The Caraorman formation (Fig. 12) represents the northern flank of the St. George I Delta and one of the oldest littoral bodies (9,000-7,200 yrs. BP). The main old beach ridges sets of the Caraorman Formation are: the initial spit, which is the starting line for the Caraorman Formation development, flanked to the east by the “Erenciuc”, “Caraorman-padure” and “Caraorman-sat” sets (from oldest to youngest).

The Caraorman village is placed on the “Caraorman-sat” set. This set is formed exclusively of the Ukrainian rivers sediments drifted along the seashore (type "a"). Low and very long ridges with swales among them make up the general landscape in the area of the village. Few kilometers to the south, an important zone of paleo-erosion occurs. The above- mentioned sets are successively cut by the younger sets Iacob, Puiuleţ I, Puiuleţ II, Lumina I and Lumina II, Roşu and Roşulet, and finally, Ivancea. These younger sets make up the eastern part of the Caraorman Formation and represent the southern wing of the Sulina Delta, consisting of Danube-borne sediments (type "b"). The paleo-erosion zone is underlined by a residual enrichment in heavy mineral fraction.

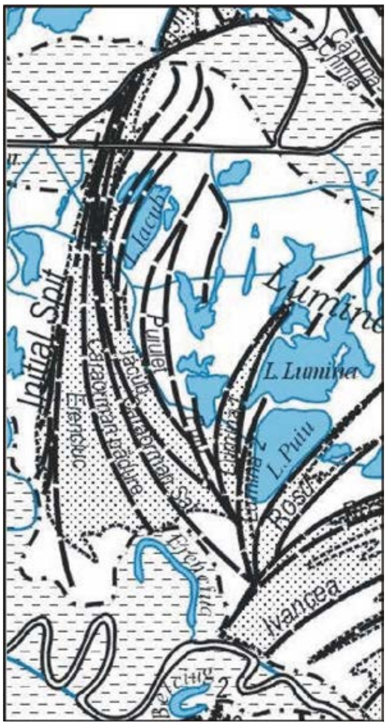

Fig. 12 – The Structure of the Caraorman littoral accumulative formation (after Panin, 1997).

The trip continues towards the “Caraorman-pădure” set by making the tour of the village and going westwards almost 1.5 km. Here, the ridges are higher and the relief is complicated by the occurrence of barchans type dunes, up to 7-8 m high (Figs. 13 and 14). This set is the "locus typicus" for studying the type "a" littoral sands.

The southern and western parts of the “Caraorman-pădure” set, as well as the Erenciuc set area lying westward, are occupied by a beautiful and very old forest (Fig. 15), mainly formed of up to 25 m high white, black and trembling poplars *(Populus alba, P. nigra, P. tremula),* oak trees *(Quercus sessiliflora),* ash trees *(Fraxinus excelsior),* elm trees *(Ulmus campestris),* white willows *(Salix alba),* osier willows *(Salix fragilis),* crab trees *(Malus sylvestris),* lime trees *(Tilia platyphyllos),* hazel trees *(Corylus avellana)* with liana-like vegetation of Virginia creeper *(Vitis sylvestris, Ampelopsis quinquefolia and A.hederacea),* hop plants *(Humulus lupulus),* tendrils *(Clematis),* eglantines *(Rosa canina),* juniper trees *(Juniperus communis),* sea buckthorns *(Hippophae rhamnoides)* etc. The most interesting of this liana-like vegetation is *Periploca graeca* of Mediterranean origin, the Caraorman area being the northernmost limit of its living area. In the depressions, among the dunes, the vegetation is represented by *Elymus sabulosus, Bromus tectorum, Agropyrum junceum, Salix rosmariniflor,* etc.

Fig. 13 – Active dunes close to Caraorman village

Fig. 14 – Standing tree stump – witness of eolian erosion and transport

Fig. 15 – "The Kneeled Oak" – seculary oak (more than 400 years) of Caraorman forest

Stop 4 – *Sulina town*

Sulina, the most eastern settlement of Romania, has a particular history. The locality is mentioned for the first time with the name *Salinas* in " De administrando Imperi" – a document from the times of Byzantine emperor Constantin Porphyrogenetes (913-959 a.d.). In Anna Comnena's "Alexiada" it is a mention of *Selinas* or *Solina* at the Calonstoma river mouth. In 1318, the town becomes Genovian port. A july 1469 document speaks about the placement of the Turkish military garrison in *Soline* and the establishment of the headquarters of regency. During Russian-Turkish war of XVIII-XIX centuries, Sulina was known only as a settlement, with 1,000-1,200 inhabitants, marked by an economical decline, piracy development and the increasing of uncertainty feeling.

The Russian-Austrian Convention signed at Sankt Petersburg in 1840 nominates *Sulina* as a river-marine port and establishes the bases for free navigation on the Danube.

In 1856, the Paris Peace Congress decided the creation of the Danube’s European Commission, with headquarters in Sulina, which foundation determined the locality’s transformation into an important town with a flourishing economy, based on commerce and navigation. The Commission was composed by the representatives of Great Britain, France, Austria, Germany (Prussia), Italy (Sardinia), Russia and Turkey.

Sulina became famous for the major hydro-technical works that regularised the mouths of the river and for the excavation of the Sulina Canal, which was co-ordinated by some of the most renowned names in the field, such as Sir Charles Hartley (1856-1907), nicknamed the “father of the Danube”, who worked with leading engineers from Britain, Austria and Germany. The arrangements made at the Danube’s European Commission initiative allowed a navigability adequate state and the development of Sulina harbour, which became in this way the most important port from the Occidental part of the Black Sea, and beginning with 1870 was the first free port (*Porto Franco*) in Romania. Simultaneously, the town knows a special urbane transformation due to the elevation of important buildings. The old lighthouse was built also in 1870 (Fig. 16).

At the end of 19th century and the beginning of the 20th century, 9 consular representations (Austriac Consulate, English, German, Italian, Danish, Greek, Russian, and Turkish Viceconsulates, and a Consulary Agency for Belgium), buildings of numerous navigation companies, post office, telephone, Danube’s European Commission Palace (Fig. 17), electrical power station, water factory (Queen's of Holland donation), two hospitals, a theatre (300 places), a hotel, several printing works, 3 mills, 70 small companies, and 154 shops were existing in Sulina. The most important shipping companies were present here: Lloyd Austria Society

(Austria), Deutsch Levante Linie - D.L.L. (Germany), Egeo (Greece), Johnston Line (England), Florio et Rubatino (Italia), Westcott Linea (Belgium), Messagerie Maritime (France), Serviciul Maritim Român.

The official documents were written in French and English and the communication language was the Greek one. There was a printing house, where journals as "Gazeta Sulinei", "Curierul Sulinei", "Delta Sulinei and "Analele Sulinei" were printed in several languages.

The image of the Sulina of former days is conjured up for us by the gravestones in the town’s cemetery, which is a record of the everyday glories and tragedies of its past, its great epidemics, and its harmonious and beneficent cosmopolitanism. Sulina’s cemetery, unique in Romania, is also a place where you will see the how all these different people coexisted. There are British and Austrians, buried next to Germans and Russians, with their resting places marked either with simple crosses or complicated monuments.

Between the 2 wars, the population number varied between 7,000-15,000, depending on the national corn harvest which was transported and stored in Sulina, which represented an attraction to different European population. The education was sustained through 2 Greek schools, 2 Romanians, 1 German, 1 Jewish, a few other confessional schools, a gymnasium and a professional school for girls, an English Marine Institute.

The religious confessions were also sustained by 4 Orthodox churches (2 Romanians, one Russian and one Armenian), a Jewish temple, an Anglican church, a Catholic church, one Protestant and two mosques.

Fig. 16 – The old lighthouse of Sulina built by the Danube European Commission (l870)

Fig. 17 – The Danube European Commission Palace in Sulina (1868)

The cannons noise leads to the decision of dissolving the Danube European Commission in 1939. Losing the neutrality meant also the dissolving of the Consulates. Cosmopolitan life in Sulina ceased its existence. The Second World War brought destruction. The economy entered decline, cultural life unravelled, and bombs felt upon the buildings of Sulina, leaving only sad, scattered fragments of the once warm, protective outlines of the town's wood-clad edifices. More, the town entered into the big restriction of the "borders zones". The commercial activities were restrained, the economical life was reduced at fishing and manufacture. During the communist period, nor the industrialisation politics, nor the reorganization of the free-port didn't manage to reactivate the Sulina's urbane life.

The 2002 census recorded 4,628 inhabitants, a marked depopulation of 20% in the last 12 years due to an accentuate decline of socio-economic life in the town. During the last years, an improvement of the economic development and especially of the touristic activities could be recorded.

4.4. Third day – 27th of September, 2013

The last day of the excursion will be a long trip from the Black Sea to the starting point of the Danube Delta. We leave Sulina town sailing upstream to west, along the main canal, up to Crişan village (Mile 14). Here, our route turns to north-west, following the Old Danube branch, and after an hour of navigation we reach the village *Mila 23* (Stop 5), a very nice fishermen settlement. From *Mila 23*, we leave the Old Danube, crossing the inner part of the Delta, through a series of artificial and natural channels (Olguţa, Şontea, Sireasa) up to Sireasa junction point (Stop 6), where we intersect the artificial canal „Mile 36". This canal is crossing the western part of the Danube Delta from north to south, shortening the distance between Kilia and Tulcea branches. Close to the Sireasa junction point, there are two important agricultural polders, which represent a good example of the harmful human influence on the natural environments. The last part of the trip follows the „Mile 36" canal to the Danube, and after 3 miles of sailing upstream, we reach Tulcea, the end of our field trip.

Stop 5 – *Mila 23 village*

Mila 23 is an authentic traditional fishing village, which still preserves typical small houses painted in blue and covered with reed. This is one of the main settlements of the Lipovans, descendants of Russian refugees, who fled from religious persecution in the early 18th century, and who make their living from fishing, livestock breeding and reed harvesting in this vast area. The village is located at 23 miles far from the Black Sea, on the right bank of the old course of the Sulina branch, known as the "Old Danube". The old course of Sulina branch was rectified between 1862 and 1902, after the founding of the Danube European Commission, with headquarters in Sulina (since 1856), which decided to improve the navigability and to make possible the passage of marine ships.

Stop 6 – *Sireasa area*

The stop is devoted to discuss the anthropogenic impact exerted on the deltaic environment.

There are many polders and fish ponds in the Danube Delta, the most important being Pardina (27,000 ha) and Sireasa (7,500 ha) agricultural polders. These anthropized areas have been created during so called *"agriculture period"* (1980-1989). All these human interventions considerably modified the local landscape and influenced the functioning of the delta ecosystem. The dammed areas increased from 24,000 ha to more than 97,000 ha and have been cut off from the Danube river pulse system (Staras, 2001).

When the works were stopped early 1990 after political changes in Romania, the dyked area of the Danube Delta comprised 97,408 ha out of which 39,974 ha were dedicated to agriculture use. These negative effects were amplified by the hydrotechnical works which destroyed about 400,000 ha of flooding area upstream (Baboianu, 2002). After 1990, the agricultural polders were used even less, due to the negative cost-benefit balance and the dry climate in the area.

End of the field trip – *Tulcea town*

Tulcea is the main entry gate to Danube Delta, placed on the border of one of the River Danube distributaries - Tulcea branch (Figs. 18 and 19). It is an industrial settlement with shipyards, aluminium plant and food industry; at the same time, it is the capital of Tulcea county, in the northern part of Dobrogea, with an area of almost 8,500 km^2 and a population of 267,000 people. The *Danube Delta Biosphere Reserve Authority* and the *Danube Delta Research Institute* are located in Tulcea.

Fig. 18 – General view of the Tulcea town, which lays on seven hills.

Fig. 19 – The promenade along the Danube River in the Tulcea town.

The apex of the Danube Delta – the first bifurcation of the Danube River (called Ceatal Izmail) is placed very close to Tulcea. The Danube Delta Biosphere Reserve covers 5,800 km^2 and is represented by the Danube Delta and the Razim-Sinoie lagoon complex. The archaeological discoveries in Tulcea county prove that life existed here 110,000 years ago. Important proofs of the neolitic cultures (Hamangia, Gumelniţa), Gaeto-Dacian settlements and Roman vestiges have been found in the county.

Tulcea was founded in the 7th century BC under the name of *Aegyssus,* mentioned in the documents of Diodorus of Sicily (3rd century BC). The Roman poet Ovidius referred to it in *Ex Ponto*, saying that its name would have originated with that of its founder, a Dacian named *Carpyus Aegyssus.* After the fights in 12-15 BC, the Romans conquered the town. They rebuilt it after their plans, their technique and architectural vision, reorganizing it. The existing ruined walls and defending towers are proof of this. Also, an inscription found at the Tulcea Museum of Archaeology mentions the name *Aegyssus* for the town. The *Aegyssus* fortified town is mentioned also by other documents until the 10th century, such as *Notitia Episcopatum* in the political geography "De Thematicus".

The city was then ruled by the Byzantine Empire (5th-7th century), the Bulgarian Empire (681-c.1000; 1185-14th century), the Genoese (l0th-13th century), it was part of the local Dobrogea polisies of Balik/Balica, Dobrotitsa/Dobrotici, and, for a brief while after 1390, ruled by the Wallachian Prince *Mircea the Old* (reigned 1386-1418).

In 1416, Tulcea was conquered and ruled for 460 years by the Ottoman Empire. The city went to Romania, together with the rest of Dobrogea, in 1878 (at the Congress of Berlin). Around 1848, Tulcea was still a small shipyard town; it received its city status in 1860, when it became a province capital.

According to the 2002 census, Tulcea has a population of 91,875 inhabitants, 92.3% of which are ethnic Romanians. Significant minority groups include Lipovan Russians (making up 3.4% of the total population), and Turks (1.4%). Most of the indigenous Bulgarians left the town in 1941, in accordance with the Treaty of Craiova. There are also Tartars, Roma (Gypsies), Greeks and Armenian, Ukrainian, Italian, Hungarian, Slovak, Croatian, Polish ethnic groups.

The city of Tulcea lays on seven hills like Rome. Some of its landmarks include St. Nicholas' Church (1865), the Azzizie Mosque (1924), the Danube Delta History Museum, the Art Museum, and the History and Archaeology Museum.

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Fig. 20 – Field trip itinerary in Dobrogea and the Danube Delta
Note: For background was used the geological map of Romania sc. 1:1,000,000 (Săndulescu *et al.*, 1978), edited by the Geological Instituite of Romania

Table 1. Contributions of Romanian and foreign authors to dating the loess - palaeosol sequences from Romanian Plain and Dobrogea (Romania), over the last half-century (Rădan, 2012).

Author/ Year	Methods used to derive/ confirm the loess/palaeosol chronostratigraphy/age	Location of sections/ profiles	Studied loess - palaeosol sequences	Derived/confirmed age of the loess/palaeosol horizons
Liteanu, E. (1961)	Classic stratigraphy ➢ geometrical criteria; ➢ lithological constitution; ➢ palaeontological proofs; ➢ geomorphological arguments	• The Romanian Plain	• "Loessoid-like deposits"	• Middle Pleistocene — Upper Pleistocene — Pleistocene/ Holocene transition • *Mindel Glacial period — Mindel-Riss Interglacial period — Riss — Riss-Würm — Würm —Pleistocene/Holocene transition*
Conea, A. (1969)	Classic stratigraphy ➢ geomorphological analysis of the Quaternary terraces; ➢ lithology and number of loess/ palaeosol horizons accumulated on the terraces (Conea, 1969, cited by Bălescu *et al.*, 2003)	• "Loess complex" in Romania	• "Loess complex" in Romania	• The most recent three loess horizons (**L1**, **L2**, **L3**): assigned to the last glacial period (Conea, 1969, cited by Bălescu, 2012); • **S1** and **S2** pedocomplexes: assigned to the last Glacial interstadials (Conea, 1969, cited by Bălescu & Lamothe, 2009 and Bălescu *et al.*, 2010)
Conea, A. (1970)	Classic stratigraphy ➢ pedostratigraphical analyses/ palaeopedological studies; ➢ geomorphological information; ➢ lithological data; ➢ physico - chemical analyses; ➢ pollen analyses; ➢ palaeontological studies; ➢ archaeological studies	• Dobrogea *Profiles* (selection): *Ghindăreşti*, *N Dunărea*, *S Dunărea*, *Seimeni*, *N Cernavodă*, *S Cernavodă*, *Rasova*, *Băneasa*, *Almalău*, *Stânca*, *Fântânele*, *Castelu*, *Mamaia*, *Ovidiu*, *Constanța*, *Agigea*, *Costineşti*, *Neptun*, *Comarova* • The Romanian Plain *Profiles*: *Slatina*, *Onceşti - Ghizdaru*, *Pintenu Măgurii (Tinosu)*	• 31 profiles with succession of various numbers of loess and fossil soil alternations	Dobrogea: • An undivided loess (in most cases **W3**); three loess horizons/subdivisions (**W3**, **W2**, **W1**), assigned to *Late Würm*, *Middle and Early Würm Glacial stage*, respectively; a lower loess horizon (possibly, divided into two), assigned to *Riss*; another possible loess layer (older): assigned to *Mindel*; • **GS1**, **GS2** ("soil groups"): assigned to two *Würmian interstadials*; • Soil group **GS3**: assigned to the *Riss - Würm Interglacial*; • **GS4**: assigned to a *Rissian interstadial*; • **GS5**: assigned to the *Mindel - Riss Interglacial*; • **GS6**: *Mindellian interstadials*; • **GS7**: assigned to *Günz -Mindel Interglacial and to older phases of the Lower Pleistocene*
Ghenea, C., Codarcea, V. (1974)	Classic stratigraphy ➢ palaeontological data; ➢ lithological/grain size - mineralogical determinations; ➢ archaeological information	• Dobrogea: *Nazarcea -Ovidiu (Nz) section* (see Fig. 1C; **Nz**)	• Six palaeosol horizons (**PsI** to **PsVI**), alternating with six loess horizons (**LI** to **LVI**)	• Loess horizons **LI**, **LII**, **LIII**, assigned to the *Würm Glacial Stage*; • The loesses and the palaeosols (**I** to **V** horizons), formed during the last part of the Pleistocene; • The palaeosol horizons **PsV** to **PsI**: the products of the climatic changes taking place within the interval: *Riss - Würm Interglacial - Würm Glacial Stage*; • Palaeolithic tools associated with the Mousterian industry - within the palaeosol horizons **PsIV** and **PsV**: not older than the *Riss - Würm Interglacial*; **PsVI**: possibly, assigned to the *Mindel - Riss Interglacial*
Rădan, S.C., Ghenea, C., Rădan, M. (1984)	➢ Magnetostratigraphic dating/ Palaeogeomagnetic polarity ✓ vertical variation (with depth) of the declination and inclination of the Primary/ Characteristic Remanent Magnetisation (*ChRM*); ✓ vertical variation of the Magnetic Susceptibility (*MS*) and of the Natural Remanent Magnetisation (*NRM*); ➢ Archaeological information	• Dobrogea: *Cernavodă* (*Cv*), *Mircea Vodă* (*MV*), *Cuza Vodă* (*CV*), *Nazarcea* (*Nz*), *Costineşti* (*Cs*) *sections* (see Fig. 1C; **Cv**, **MV**, **CV**, **Nz**, **Cs**)	• Maximum six loess horizons (**L1** to **L6**), alternating with six palaeosol horizons (**PsI** to **PsVI**) (*MV*, *CV*, *Nz*, *Cs*); • Loess deposits only (*Cv*)	• Middle Pleistocene - Upper Pleistocene; • Normal polarity associated with the *Brunhes Chron* (*C1n*): • *Updated* (Rădan, 2012; present paper): Age not older than **781 ka** [according to the correlation to *Brunhes Chron* of *ATNTS2004* (Lourens *et al.*, 2004) / *ATNTS2012* (Hilgen *et al.*, 2012a,b)]; • The loess from the Cernavodă profile: the upper part of the last glaciation (Ghenea, in Rădan *et al.*, 1984)

Table 1 (*Continued*).

Author/ Year	Methods used to derive/ confirm the loess/palaeosol chronostratigraphy/age	Location of sections/ profiles	Studied loess - palaeosol sequences	Derived/confirmed age of the loess/palaeosol horizons
Rădan, S.C., Rădan, M. (1984a)	➢ Palaeogeomagnetic polarity/ Magnetostratigrafic method; ✓ vertical variation of the declination and inclination of the Primary/Characteristic Remanent Magnetisation (*ChRM*); ✓ vertical variation of Magnetic Susceptibility (*MS*) and of Natural Remanent Magnetisation (*NRM*); ➢ (Palaeo)geomagnetic polarity dating, integrated within the *Geological map of Romania*, scale 1:50,000 - *Medgidia sheet* (Eds.: Ghenea *et al.*, 1984a)	• Dobrogea: *Nazarcea section* (*Nz*) (see Fig. 1C; **Nz**)	• Six loess horizons (**LI** to **LVI**), alternating with six palaeosol horizons (**PsI** to **PsVI**)	• Middle Pleistocene - Upper Pleistocene; • Normal polarity associated with the *Brunhes Chron* (*C1n*): ➢ *Updated* (Rădan, 2012): Age of the upper part of the lowermost palaeosol (**PsVI**): not older than **781ka** (according to the correlation to *ATNTS2004/ ATNTS2012*)
Rădan, S.C., Rădan, M. (1984b)	➢ Palaeogeomagnetic polarity/ Magnetostratigrafic method ✓ vertical variation of declination and inclination of the Primary/Characteristic Remanent Magnetisation (*ChRM*); ✓ vertical variation of Magnetic Susceptibility (*MS*) and of Natural Remanent Magnetisation (*NRM*); ➢ Palaeogeomagnetic polarity dating, integrated within the *Geological map of Romania*, scale 1:50,000 - *Peştera sheet* (Eds.: Ghenea *et al.*, 1984b)	• Dobrogea: *Mircea Vodă (MV) section* (see Fig. 1C; **MV**)	• A sequence of six loess horizons (**LI** to **LVI**), alternating with six palaeosol horizons (**PsI** to **PsVI**)	• Middle Pleistocene - Upper Pleistocene; • Normal polarity associated with the *Brunhes Chron*; ➢ *Updated* (Rădan, 2012): Age of the central part of the lowermost loess investigated (**LVI**): not older than **781ka** (according to the correlation to *ATNTS2004/ATNTS2012*)
Rădan, S.C., Ghenea, C., Rădan, M. (1990)	➢ Palaeogeomagnetic polarity/ Magnetostratigraphic method ✓ vertical variation of declination and inclination of the Primary/Characteristic Remanent Magnetisation (*ChRM*); ✓ vertical variation of Magnetic Susceptibility (*MS*) and of Natural Remanent Magnetisation (*NRM*); ➢ Archaeological information;	• Dobrogea: *Cernavodă* (*Cv*), *Mircea Vodă* (*MV*), *Cuza Vodă* (*CV*), *Nazarcea* (*Nz*), *Costineşti* (*Cs*), *sections* (see Fig. 1C; **Cv**, **MV**, **CV**, **Nz**, **Cs**)	• Maximum six loess horizons (**LI** to **LVI**), alternating with six palaeosol horizons (**PsI** to **PsVI**)	• Middle Pleistocene - Upper Pleistocene; • The loess deposits from the Cernavodă profile: upper part of the last glaciation; • Normal polarity associated with the *Brunhes Chron*; • *Updated* (Rădan, 2012): age of the loess and palaeosol horizons (**LI** to **LVI**; **PsI** to **PsVI**): not older than **781 ka** (according to the correlation to the *Brunhes Chron* of *ATNTS2004/ ATNTS2012*);
Król, E. (in Rădan *et al.*, 1990)	➢ Thermoluminescence (*TL*) dating			• **650ka±90ka**: the lowermost palaeosol horizon (**PsVI**) - *Costineşti section*
Pagáč, P. (1990)	➢ Palaeomagnetic/ Magnetic polarity method	• Dobrogea: ✓ *Costineşti* (*Cs*) ✓ *Cernavodă* (*Cv*) profiles (see Fig. 1C; **Cs** and **Cv**)	• Three loess (**L3**, **L4**, **L6**) and four palaeosol (**S3**, **S4**, **S5**, **S6**) horizons investigated (*Cs profile*); • Loess deposits (*Cv profile*)	• Middle Pleistocene - Upper Pleistocene; • Only normal polarity along the two fragments investigated within the two profiles (*Cs* and *Cv*)
Ghenea, C., Rădan, S.C. (1993), *updated* by Rădan (2012; present paper)	➢ Palaeogeomagnetic polarity/ Magnetostratigraphic method ✓ vertical variation of declination and inclination of the Primary/ Characteristic Remanent Magnetisation (*ChRM*); ✓ vertical variation of Magnetic Susceptibility (*MS*) and of Natural Remanent Magnetisation (*NRM*);	• Dobrogea: ✓ *Costineşti* (*Cs*) section; ✓ *Nazarcea-Ovidiu* (*Nz*) section (see Fig. 1C; **Cs** and **Nz**)	• Six loess horizons (**LI** to **LVI**), alternating with six palaeosol horizons (**PsI** to **PsVI**)	• Middle Pleistocene - Upper Pleistocene; • Normal polarity only, identified in the two sections (*Cs*, *Nz*), associated with the *Brunhes Chron*; • Age not older than **730 ka** [according to the *Pliocene - Pleistocene Geomagnetic Polarity Time Scale* of Mankinen and Dalrymple (1979), in Butler (1992)]; *Updated* by Rădan (2012; present paper) : the *Matuyama / Brunhes* boundary - **781 ka** (according to *ATNTS2004/ATNTS2012*);
Król, E. (in Rădan *et al.*, 1990)	➢ Thermoluminescence (*TL*) dating			• **650ka±90ka**, **PsVI** - the lowermost paleosol horizon (**PsVI** - *Costinesti section*)

Table 1 (*Continued*).

Author/ Year	Methods used to derive/ confirm the loess/palaeosol chronostratigraphy/age	Location of sections/ profiles	Studied loess - palaeosol sequences	Derived/confirmed age of the loess/palaeosol horizons
Rădan, S.C. (1998); Rădan & Rădan (1998)	➢ (Palaeo)geomagnetic polarity/ Magnetostratigraphic method	• Dobrogea: ✓ *Cernavodă* (*Cv*), *Mircea Vodă* (*MV*), *Cuza Vodă* (*CV*), *Nazarcea* (*Nz*), *Costineşti* (*Cs*) *sections*; ✓ *Popina Isle* (*PIs*) - northern Razelm Lake; ✓ *Jurilovca* (*Jv*) - northern border of Goloviţa Lake; • The Romanian Plain: *Drănic* (*Dn*) *section* (see Fig. 1C; **Dn**, **Cv**, **MV**, **CV**, **Nz**, **Cs**, **PIs**, **Jv**)	• Maximum six loess horizons (**LI** to **LVI**), alternating with six palaeosol horizons (**PsI** to **PsVI**) (*MV*, *CV*, *Nz*, *Cs*); • Only loess deposits (*Dn*, *Cv*, *PIs*, *Jv*)	• Middle Pleistocene - Upper Pleistocene; • Age of all the investigated loess and palaeosol horizons: not older than **781 ka** (according to the correlation to *Brunhes Chron*; A*TNTS2004*/ *ATNTS2012*); • The loess from the *Cernavodă* section: upper part of the last glaciation (Ghenea, 1984, in Rădan *et al*., 1984)
Rădan (2000), in Enciu *et al*. (2000), *updated* by Rădan (2012; present paper)	➢ Rock-magnetic method; ✓ vertical variation (with depth) of the magnetic susceptibility (*MS*); ✓ anisotropy of magnetic susceptibility (*AMS*); ➢ (Palaeo)geomagnetic polarity/ Magnetostratigraphic method ➢ Correlation to the magnetic susceptibility variations with depth, with the magnetostratigraphic data and with the benthic $\delta^{18}O$ record of *ODP site* record (Shackleton *et al*., 1990), in the Lingtai loess - palaeosol section from the Chinese Loess Plateau (Yang and Ding, 2010; Spassov, 2002), and with other (palaeo) magnetic signatures recovered, *e.g*., from sections in Bulgaria and Serbia	• The Romanian Plain: ✓ *F3-Zimnicea* geological borehole profile (*ZBhP*) (see Fig. 1C; **Zm**)	• A tentative structure of the loess - palaeosol sequence of ca 30m thickness, traversed by a geological borehole, supported by the magnetic susceptibility variations with depth, is referred to an alternance of 8 loess/loess-like (**L1** to **L8**) and 7 palaeosol (**S1** to **S7**) horizons; still a possible palaeosol horizon (**S8**?)	• Middle Pleistocene - Upper Pleistocene, from ca 29 m (and ca 28m, respectively) borehole depth upwards, and Lower Pleistocene, from that depth downwards (up to ca 39m depth at least - the base of the investigated borehole): according to the "observed", and "corrected/true", respectively, Matuyama / Brunhes boundary (*MBB*) location (*MBB*: dated at **0.781 Ma**; ATNTS2004/ATNTS 2012) (see the paper text and Fig. 2); • The analysed loess - palaeosol sequence was deposited during a time interval ending with *MIS 20* - **L8** (possibly *MIS 21* - **S8**?); ✓ the "corrected *MBB*" (placed within **S7**, lower part) is coincident with the base of *MIS 19*, confirming the data of Shackleton *et al*. (1990); ✓ a very good correlation/equivalence of the *ZBhP* with the magnetic susceptibility record at Lingtai and Jingchuan (Chinese Loess Plateau), and with the "observed", and the "corrected", respectively, *MBB*" location in these two sections (within **L8**, and lower part of **S7**, respectively); • The studied loess - palaeosol borehole profile (*ZBhP*) spans **800ka**, at least.
Panaiotu, C.G., Panaiotu, C.E., Grama, A., Necula, C. (2001)	➢ Rock-magnetic method: ✓ Vertical variation (with depth) of several rock magnetic parameters: low frequency susceptibility (χ_{lf}), Isothermal Remanent Magnetisation (IRM_{200mT}), Anhysteretic Remanent Magnetisation (ARM_{100mT}), frequency-dependent susceptibility (χ_{fd} %), ratio ARM/ IRM. ➢ Correlation of susceptibility variation in the Mostiştea profile with similar values recorded from the loess -palaeosol sections at "Koriten" - Bulgaria (Jordanova & Petersen, 1999) and "Packs" (Hungary; Sartori *et al*., 1999, cited by Panaiotu *et al*., 2001); ➢ Correlation of susceptibility variation with the astronomically tuned marine $\delta^{18}O$ record from ODP 677 site	• The Romanian Plain: *Mostiştea profile (Ms)* (see Fig. 1C; **Ms**)	• Four loess horizons (**L1** to **L4**), three interbedded palaeosol complexes (**S1** to **S3**) and a recent soil at the top (**S0**)	• Paleosol **S1**: correlated with the Interglacial interval corresponding to *isotope stage 5*; **S2**: correlated with the Interglacial interval corresponding to *isotope stage 7*; **S3**: correlated with the Interglacial interval corresponding to *isotope stage 9*; • The loess horizons correlate with corresponding Glacial intervals; • Maximum age of the studied profile at *Mostiştea Lake*: probably, less than **0.4 Ma**

Table 1 (*Continued*).

Author/ Year	Methods used to derive/ confirm the loess/palaeosol chronostratigraphy/age	Location of sections/ profiles	Studied loess - palaeosol sequences	Derived/confirmed age of the loess/palaeosol horizons
Bălescu, S., Lamothe, M., Mercier, N., Huot, S., Bălteanu, D., Billard, A., Hus, J. (2003)	➢ Infrared Stimulated Luminescence (*IRSL*) dating method, using: ✓ multiple aliquot additive γ dose technique (*MA*) on multigrain aliquots; ✓ single-aliquot regenerative-β dose (*SAR*) method on very small aliquots; ✓ three protocols of age correction for the observed fading	Dobrogea: • *Tuzla/Tz* (Black Sea Shore); The Romanian Plain: • *Giurgiu* (*Malu-Roşu/ MR*) (see Fig. 1C; **MR**, **Tz**)	• Seven palaeosol complexes (**S1** to **S7**) below the surface soil, and seven interbedded loess horizons (**L1** to **L7**)	• Middle and Upper Pleistocene; ➢ *Malu Roşu profile* (*MR*) ✓ a sample collected 20 cm below the Upper Palaeolithic occupation level: Upper Pleistocene; corrected *IRSL* age: 30±4 ka; expected geological age: > 22,790±120 years; > 21,140±130 years ➢ *Tuzla section* (*Tz*) • **L1**: ✓corrected *IRSL* age: 51±5 ka; 52±5 ka; *GLSL age*: 63±8 ka; ✓ expected geological age: *0 I Stage 4*; • **L2**: corrected *IRSL* age: > 140±22 ka; 163±23ka; 176±25 ka; expected geological age: *0 I Stage 6* (130-200ka); • **L3**: corrected *IRSL* age: > 218±42ka; 250±43ka; 267±46ka; expected geological age: *0 I Stage 8* (250-300ka); • **L7** (lowermost loess horizon of *Tuzla section*): ✓ expected geological age: *0 I Stage 20* (**800 ka**)
Panaiotu, C.E., Bălescu, S., Lamothe, M., Panaiotu, C.G., Necula, C., Grama, A. (2004)	➢ Rock-magnetic method; ➢ Sedimentological and clay mineral analyses; ➢ Astronomical calibration by tuning the magnetic parameters with the insolation and eccentricity curves (following the method of Heslop *et al.*, 2000); ➢ Infrared Stimulated Luminescence (*IRSL*) dating method	The Romanian Plain: • *Mostiştea/Ms* (see Fig. 1C; **Ms**)	• Four loess layers (**L1** to **L4**), two chernozem palaeosols (**S1**, **S2**) and two brown-reddish palaeosols (**S3**, **S4**)	• **S1**, **S2**, **S3**: interglacial palaeosols; • **L1** (lower part) was deposited during *MIS 4*; • **L2**: during *MIS 6*; • **L3**: during *MIS 8*; • The maximum age of the section (**Ms**) is around **400 ka**; • Entire section (**Ms**) was accumulated during a period within the *Bruhnes chron*
Necula, C., Panaiotu, C. (2008)	➢ Dynamic programming method: ✓ tuning magnetic susceptibility to: - the 65°N summer insolation record; - the stack of 57 globally distributed benthic $\delta^{18}O$ records	The Romanian Plain : • *Mostiştea (Ms) profile* (on the border of the Mostiştea Lake) (see Fig. 1C; **Ms**)	• Four loess horizons (**L1** to **L4**), three interbedded palaeosols (**S1** to **S3**) and a recent soil (**S0**)	• The age of the loess - palaeosol sequence (*Ms section*): around **433 ka**; • **S1** matches with *MIS 5*; • **S2** matches with *MIS 7*; • **S3** matches with *MIS 9*; • **S4** matches with *MIS 11*
Buggle, B., Hambach, U., Glaser, B., Gerasimenko, N., Marković, S., Glaser, I., Zőller, L. (2009)	➢ Palaeopedology/ Pedostratigraphy; ➢ Correlations of the magnetic susceptibility curves recorded for the investigated loess - palaeosol profiles with the astronomically tuned stacked records of Lingtai and Zhaojiachuan "stratotype sections" from the Chinese Loess Plateau (Sun *et al.*, 2006); ➢ Correlations of the magnetic susceptibility records with the $\delta^{18}O$ record of benthic foraminifera of ODP 677 (situated in the Eastern tropical Pacific; 1°12′N, 83°44′W; Shackleton *et al.*, 1990), as proxy for the global ice volume; ➢ Validation of the obtained chronostratigraphy against existing chronostratigraphic models of other loess - palaeosol sequences in the region (Serbia, Bulgaria, Romania, Ukraine)	Dobrogea: • *Mircea Vodă* (*MV*); The Romanian Plain : • *Mostiştea* (*Ms*) (see Fig. 1C; **Ms**, **MV**)	• Six palaeosol horizons/ pedocomplexes (**S1** to **S6**), alternating with six loess horizons (**L1** to **L6**): **MV** section; • Three palaeosol horizons (**S1** to **S3**) and four loess horizons (**L1** to **L4**): **Ms** section	• **S1** unit is assigned to *Marine Isotope Stage MIS 5*; • **S2** pedocomplex is correlated with *MIS 7*; • **S3** pedocomplex is assigned to *MIS 9*; • **S4** is correlated with *MIS 11*; • **S5** palaeosol may serve as a marker horizon for *MIS 13 – 15*, in the area (Buggle *et al.*, 2009); • **L6** is assigned to *MIS 16*; • The oldest soil **S6** is correlated at least to *Marine Isotope Stage* (*MIS*) *17* (interglacial); **S6** (**MV**) is rather correlated with the Chinese **S6** (Buggle *et al.*, 2009); **MV** section: an age around **700ka**

Table 1 (*Continued*).

Author/ Year	Methods used to derive/ confirm the loess/palaeosol chronostratigraphy/age	Location of sections/ profiles	Studied loess - palaeosol sequences	Derived/confirmed age of the loess/palaeosol horizons
Bălescu, E., Lamothe, M. (2009)	➢ Infrared Stimulated Luminescence (*IRSL*) dating method, using ✓ the multiple aliquot γ dose technique; ✓ the *IRSL* ages, corrected by using the protocol of Mejdahl (1988; cited by Bălescu and Lamothe, 2009)	Dobrogea: • *Tuzla/Tz* (Black Sea Shore); • *Mircea Vodă (MV)* The Romanian Plain: • *Mostiştea (Ms)* (see Fig. 1C; **Ms**, **MV**, **Tz**)	• Four to seven loess horizons (**L1** to **L7**, downwards), alternating with palaeosol horizons (**S1** to **S7**)	• The three upper loess horizons (**L1**, **L2**, **L3**), assigned to the last three Pleistocene glaciations (*MIS 2* to *4*, *MIS 6*, *MIS 8*); • The last Interglacial soil (*MIS 5e*) corresponds to paleosol **S1**; • First chernozem soil horizon (*i.e.*, paleosol **S2**), formed during *MIS 7*
Timar-Gabor, A., Vasiliniuc, S., Vandenberghe, D.A.G., Cosma, C. (2009)	➢ Optical Stimulated Luminescence (*OSL*) method	Dobrogea: • *Mircea Vodă (MV)*; • *Costinesti (Cs)*; The Romanian Plain: • *Mostiştea (Ms)* (see Fig. 1C; **Ms**, **MV**, **Cs**)	• **MV** section: Five palaeosols (**S1** to **S5**), recent topsoil (**S0**) and the interbedded loess horizons; • **Cs** section: investigated - **L1** and **L2**; • **Ms** section: investigated - **L1**, **S1**, **L2**	• Uppermost soil horizon (**S1**): formed during the last Interglacial
Bălescu, S., Lamothe, M., Panaiotu , C.E., Panaiotu, C.G. (2010)	➢ Infrared Stimulated Luminescence (*IRSL*) dating method	The Romanian Plain: • *Mostiştea (Ms) section*; Dobrogea: • *Mircea Vodă section (MV)* (see Fig. 1C; **Ms**, **MV**)	• **L1**, **L2**, **L3** loess horizons; • **S1**, **S2** pedocomplexes	• **L1**, **L2**, **L3** are assigned to the last three Pleistocene glaciations *MIS 2* to *4*, *MIS 6* and *MIS 8*, respectively; • Soil from the last Interglacial (*MIS 5e*) corresponds to the pedocomplex **S1**; • The development of the first chernozem pedocomplex (**S2**) within the loessic sequences took place, in southeastern Romania, during *MIS 7*
Timar-Gabor, A., Vandenberghe, D.A.G., Vasiliniuc, S., Panaiotu, C.E., Panaiotu, C.G., Dimofte, D., Cosma, C. (2011)	➢ Optical dating method (*SAR-OSL* technique): ✓ Optically Stimulated Luminescence dating (*OSL*); ✓ single-aliquot regenerative-dose (*SAR*) protocol; ➢ study of grain-size distribution with depth; ➢ comparison of the OSL characteristics and age of fine sand-sized (63–90 μm) quartz to those of silt-sized quartz	Dobrogea: • *Mircea Vodă (MV) section* (see Fig. 1C; **MV**)	• The *MV* loess -palaeosol sequence: at least, five glacial/ interglacial cycles	• Both sets of ages (obtained by using silt-sized and sand-sized quartz) do confirm that the first well-developed palaeosol (**S1**) is of *last Interglacial* age
Vasiliniuc, Ş., Timar-Gabor, A., Vandenberghe, D.A.G., Panaiotu, C.G. , Begy, R.CS., Cosma, C. (2011)	➢ Quartz-based SAR-OSL dating method: ✓ Optically Stimulated Luminescence (*OSL*) signals from quartz, in combination with the single-aliquot regenerative-dose (*SAR*) protocol; ➢ Comparison between the magnetic age-depth model and the OSL ages	The Romanian Plain: • *Mostiştea (Ms) profile*; ➢ Comparison between *Mostiştea* (*Ms*; Romanian Plain) and Mircea Vodă (*MV*; Dobrogea) sections (see Fig. 1C; **Ms**, **MV**)	• Four loess -palaeosol units (**L1**, **S1** to **L4**, **S4**) and the Holocene topsoil (**S0**); Investigated**: L1** - **S1** - **L2** (25cm below the **L2** top) sequence	• OSL ages obtained for the **L1** - **S1** - **L2** (25cm below the **L2** top) sequence: between 46±7ka - 144±21ka; • The *SAR-OSL* ages confirm the chronostratigraphic position of **S1**: formed during *MIS 5*; this is also in accordance with the *IRSL* chronology established by Bălescu *et al.* (2010) at this locality; • **L1**/**S1** sequence represents the Last Glacial/ Interglacial cycle (in both **Ms** and **MV** sections)
Bălescu, S. (2012)	➢ Optical Stimulated Luminescence (*OSL*) method; ➢ Archaeological information	Dobrogea: • *Mircea Vodă (MV)* • *Tuzla/Tz* (Black Sea Shore); (see Fig. 1C; **MV**, **Tz**)	• References to **L1**, **L2**, **L3** loess horizons	• Loess horizons **L1**, **L2**, **L3** formed during the last three Quaternary glacial periods (references to Bălescu *et al*., 2003, 2010): 10ka - 115ka (**L1**); 130ka - 200ka (**L2**); 250ka -300ka (**L3**) ; • Several levels of lithic industries of the Middle and Upper Palaeolithic found within the loess

Table 1 (*Continued*).

Author/ Year	Methods used to derive/ confirm the loess/palaeosol chronostratigraphy/age	Location of sections/ profiles	Studied loess - palaeosol sequences	Derived/confirmed age of the loess/palaeosol horizons
Fitzsimmons, K.E., Marković, S.B., Hambach, U. (2012)	➢ correlation of the magnetic susceptibility records (loess - palaeosol profiles from Hungary, Croatia, Serbia, Bulgaria and Romania) with: ✓ marine oxygen isotope stages (*MIS*); ✓ the stacked normalized magnetic susceptibility curves of Lingtai and Zhaojiachuan (Chinese Loess Plateau; Sun *et al*., 2006); ✓ the astronomically tuned oxygen isotope records from *ODP site 677* (Shackleton *et al*., 1990), and the orbitally tuned *SPECMAP* (*SPECtral MApping Project*) oxygen isotope record, respectively (Martinson *et al*., 1987; Opdyke & Channell, 1996)	• A review of the loess of the middle and lower Danube basin; • The loess - palaeosol sequences from Hungary, Croatia, Serbia, Bulgaria and Romania ➢ The Romanian Plain: *Mostiştea/Ms*; ➢ Dobrogea: *Mircea Vodă/MV* (see Fig. 1C; **Ms**, **MV**)	• Maximum five palaeosol horizons (**S1** to **S5**), alternating with loess horizons (concerning the sections from Romania)	• The palaeosol (**S1**) is connected to the last Interglacial (*MIS 5*); • The palaeosol **S2** is associated with *MIS 7*; • **S3**: associated with *MIS 9*; • **S4**: associated with *MIS 11*; • **S5**: associated with *MIS 13-15*; • Both profiles from Romania were correlated with the *Brunhes Chron* [*Matuyama /Brunhes* boundary (781ka): not identified]; • The "young loess" comprises the five uppermost major loess - palaeosol packages, corresponding to ~ **650 ka** (*MIS 16 - 1*)
Buggle, B., Hambach, U., Kehl, M., Zech, M., Gerasimenko, N., Marković, S., Glaser, B., Zöller, L. (2012)	➢ palaeopedological – geochemical multiproxy approach, involving: ✓ grain size analyses; ✓ micromorphological observations; ✓ geochemically based weathering indices; ✓ diffuse reflectance spectroscopy for the determination of the iron oxide assemblage; ✓ rock magnetic parameters ; ✓ n-alkanes as biomarkers for the tree *vs*. grass abundance; ➢ correlation of characteristic fingerprints of the magnetic susceptibility to proxy curves for the global ice volume; ➢ supplemented by pedo-, and tephrostratigraphic marker, allowing correlations to previously established chronostratigraphies from profiles in the region, as well as from Chinese stratotype sections	• Key sections in the Lower Danube Basin and the Middle Danube Basin (Carpathian Basin, Pannonian Basin) Dobrogea: • *Mircea Vodă section* (*MV*) (see Fig. 1C; **MV**)	• Six palaeosol horizons/ pedocomplexes (**S1** to **S6**), alternating with loess horizons	• The chronostratigraphic placement of the pedocomplexes (*MV* section): • **S1** = *MIS 5*; • **S2** = *MIS 7*; • **S3** = *MIS 9*; • **S4** = *MIS 11*; • **S5** = *MIS 13-15*; • **S6** = *MIS 17* • The loess - palaeosol sequence comprises the last **700 ka** of climate history, *i.e.* the last 17 *Marine Isotope Stages*

Note. To maintain the historical character of the synopsis, some specific constituents are expressed/labelled as in the original papers, as follows: **a)** The loess horizons are labelled (columns **4** and **5**, in the Table) as in the original papers (see column 1 and References), *e.g.*, **Ll**, **L1** - the first loess horizon; **Psl**, **S1** - the first palaeosol horizon (in both cases, starting from the top of the section/profile downwards). *Exception*: Conea (1970), where **W3** is the first loess layer starting from the top; yet, **GS1** is the first "group of soils", starting from the top; **b)** The acronyms for the "oxygen-isotope stages" (column **5**) are labelled as in the original papers (see column 1 and References), *e.g. MIS* (Marine Oxygen Isotope Stage), *OIS* (Oxygen Isotope Stage). As concerns the early publications, the Quaternary glacial stages *Günz*, *Mindel*, *Riss*, *Würm* and corresponding Interglacial periods (*i.e.*, *Günz-Mindel*, *Mindel-Riss*, *Riss-Würm*) are mentioned (column **5**), as the authors have used them in their papers.

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