THE USE OF MAGNETIC SUSCEPTIBILITY TO STUDY (HYDRO)SEDIMENTARY ENVIRONMENTS AND PROCESSES IN DANUBE DELTA

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Abstract. The paper is focused on some results obtained during the interval 2006 – 2009, concerning the bottom sediments fingerprinting in 10 main lakes of the **Danube Delta** (DD), using a composite magnetic susceptibility (**MS**; **k**)-lithological tracer. However, some remarks to the previous data obtained within the last three decades are also done. The bottom sediments were collected with "van Veen"-type grab samplers. "Confined" *vs* "dynamic" *vs* "intermediate" deltaic environments are compared and defined by particular magnetic fingerprints recovered from lake sediments. The "*dynamic environments*", usually placed close to the influx points of the master canals or connected by relatively short canals to the main DD branches, are reflected by intermediate and high **MS** values, which are assigned to **k** classes **III**, **IV** and **V** of the **MS** scale achieved by the authors (Rădan & Rădan, 2007). The "*confined environments*", situated far from the Danubian supplies and from the direct riverine inputs, are characterised by a low intensity **MS** fingerprint, that is assigned to the lower **k** classes **I** and **II**, whereas the "*intermediate*" category is defined by **k** classes **II** and **III**. A distribution model points out the composition changes of the DD lake sediments, as the distance related to the Danubian source increases: the greater the distance to the source, the richer the sediments in organic matter and poorer in detrital mineral material. Several correlation coefficients (**r**) were calculated, *e.g.* related to **k** *vs* **TOM** (Organic matter), **k** *vs* **CAR** (Carbonate fraction), **k** *vs* (**TOM+CAR**) and **k** *vs* **SIL** (siliciclastic/mineral fraction). In addition to all these data, the diagrams showing the vertical distribution of the **MS** values for four sediment cores taken from three DD lakes are presented. The results demonstrate the abilities of the magnetic susceptibility as a lake sediments fingerprinting tool used for integrated lithological, hydrosedimentary and environmental-geoecological studies in deltaic lakes.

Key words: environmental magnetism, magnetic susceptibility, lithology, recent sediments, Danube Delta.

1. INTRODUCTION. STUDY AREAS

The paper is focused on the results achieved during the 2006 – 2009 time span, regarding the bottom sediments fingerprinting in the main lakes of the Danube Delta, using a composite magnetic susceptibility (**MS**; **k**)-lithological tracer. The bottom sediments were sampled from 10 lakes (Fig. 1), located in the interdistributary depressions from both the Fluvial Delta Plain (*Lungu*, *Tătaru*, *Uzlina*, *Isacova*, *Merhei*, *Matița* and *Poludionca lakes*) and the Fluvio-Marine Delta Plain (*Puiu*, *Roşu* and *Roşuleț lakes*). Integrated magneto-lithological models show the characteristics associated with each investigated lake. Confined *vs* dynamic *vs* intermediate deltaic environments are compared and defined by particular magnetic fingerprints recovered from bottom sediments. The **MS** regimes determined for the investigated deltaic environments are in agreement with the data based on the lithological classification ternary diagrams. A very good connection is revealed between the variation ranges of the **k** values and the "lithological fields" of a ternary diagram in which the sediment samples are projected, that define mineral-organic, organic-mineral, organic, mineral or mineral-carbonate sediments.

The integration of these results allows a quantified reasoning of the differentiation of the Danube Delta underwater sedimentary environments, and also of the hydrosedimentary processes. In addition to all these data obtained for sediments collected with grab samplers, the diagrams showing the vertical distribution of the **MS** values for several sediment cores taken from the *Lungu*, *Isacova* and *Roşu* lakes are presented.

2. LOGISTICS, GEOMATERIALS AND METHODS

The data that are here analysed are mainly based on the collections taken during the 2006 and 2009 cruises. The field trips have been performed on board of the fluvial research vessel "*Istros*" and the motor-boat "*Măriuca*". Sediment sampling station networks have been conceived, so that the lacustrine areas were uniformly covered. Relatively undisturbed "sediment packets" were collected by using "*van Veen*"-type grab samplers. Besides, a number of short sediment cores (less than 56 cm long) were taken from several deltaic lakes.

The main lithological components (organic matter, carbonates and detrital siliciclastic material) have been determined by Dr. Consuela Milu – University of Bucharest (in Rădan *et al.*, 2006, unpublished scientific report, *Geological Institute of Romania/GIR Archive*, Bucharest, Romania). Ternary diagrams were drawn up to show the lithological classification of the bottom sediments. The **MS** measurements on unconsolidated sediment samples were done with KLY Kappabridges. To calibrate the lake sediments, a Magnetic Susceptibility (**k**) Scale (Rădan & Rădan, 2007) was used (Fig. 2).

Based on the magnetic susceptibility values (**k**) and the contents of the lithological components (*i.e.* **TOM** – *Total organic matter*; **CAR** – *Carbonate fraction*; **SIL** – *Mineral/Siliciclastic fraction*), achieved for the investigated lake sediments, several correlation coefficients (**r**) were calculated.

3. RESULTS AND DISCUSSION

Magnetic signatures were recovered from the bottom sediments sampled in various aquatic ecosystems and their intensities were evaluated and compared. The lake sediments fingerprinting was carried out in four main zones of the Danube Delta (Fig. 1): **1.** *Lungu – Tătaru* (Meşteru – Fortuna Depression); **2**. *Uzlina – Isacova* (Gorgova – Uzlina Depression); **3**. *Puiu – Roşu – Roşuleţ* (Lumina – Roşu Depression); **4**. *Matiţa – Poludionca – Merhei* (Matiţa – Merhei Depression).

3.1. Lungu – Tătaru area (Meşteru – Fortuna Depression)

A discussion concerning the lake sediments fingerprinting using composite magneto-lithological signatures of the bottom sediments sampled from the *Lungu* and *Tătaru Lakes* (Fig. 1; Fig. 4a), during the 2006 cruise, was presented in a recently published paper (Rădan & Rădan, 2009). After the human intervention in the western part of the depression (digging the "*Mila 36*" *Canal*, in 1982-1983), the silting-up process became very strong, especially in the northern half of the *Lungu Lake*, which is permanently washed by the waters coming from the *Canal*.

Instead, the double protection against the direct Danubian supplies, which characterises the *Tătaru Lake* (Fig. 4a), has resulted in not very important changes within the lacustrine ecosystem from this sector. The magnetic susceptibility (**MS**) signatures recovered from the bottom sediments are reliable proofs in this respect; a composite magnetic **MS**-lithological tracer is used by the authors. Strong positive correlations for **k** *vs* **SIL** were obtained, whereas moderate and strong

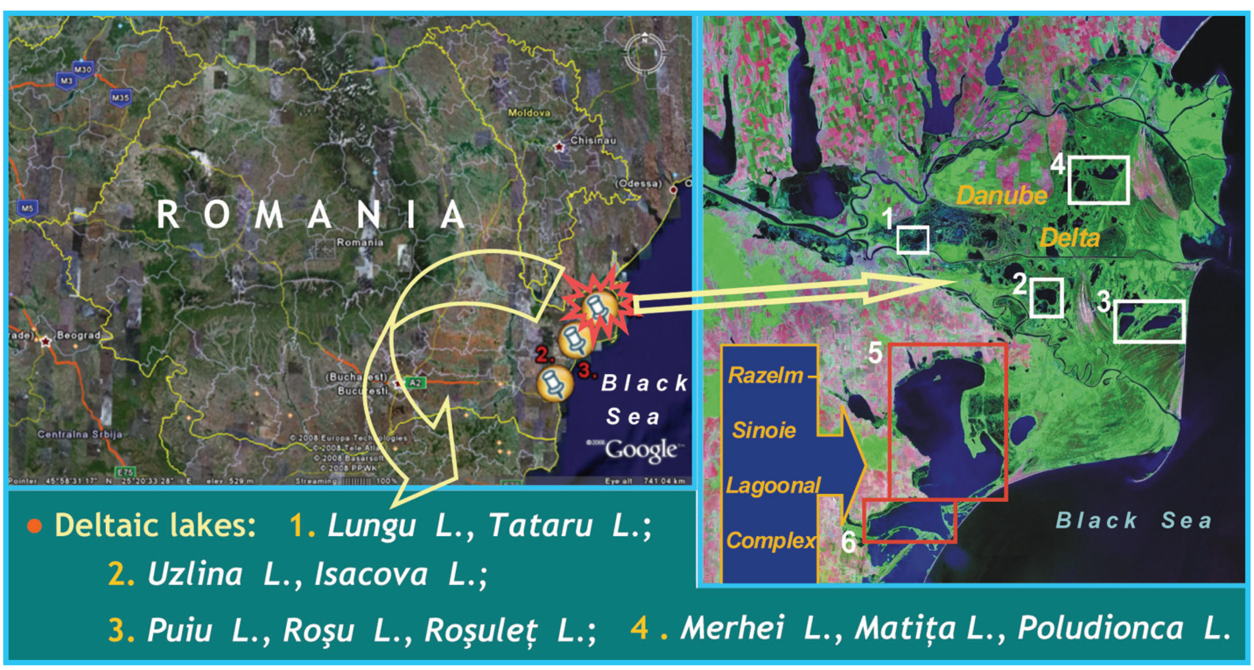


Fig. 1 Aquatic areas and location of the magneto-lithologically investigated lakes in the Danube Delta. **1**. Lungu – Mesteru Depression; **2**. Gorgova – Uzlina Depression; **3**. Lumina – Roşu Depression; **4**. Matiţa – Merhei Depression.

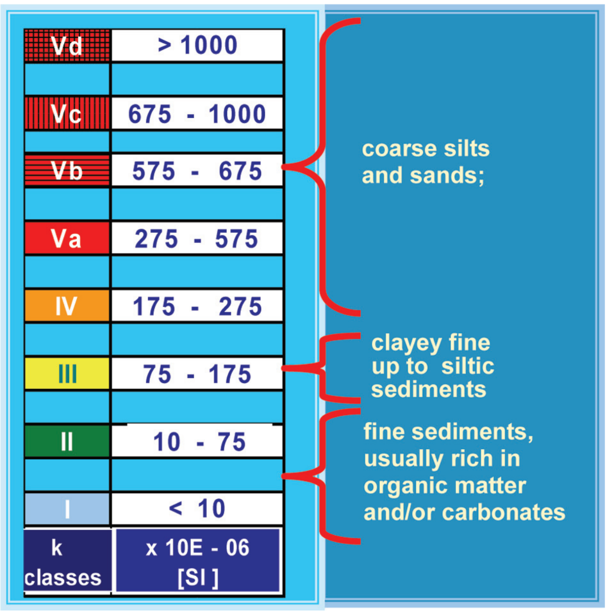


Fig. 2 Magnetic susceptibility scale used for the calibration and the classification of the bottom sediments.

negative correlations were calculated for **k** *vs* **TOM** and **k** *vs* **CAR**, and, respectively, for **k** *vs* (**TOM**+**CAR**) (Rădan & Rădan, 2009).

The synoptic pattern from Fig. 3, based on the sediments sampled during the period 1980 – 2006 from five lakes of the Meşteru – Fortuna Depression, shows – related to the *Lungu Lake* (marked by an arrow) – a clear difference between the magnetic susceptibility of the bottom sediments sampled in the 1987 – 1998 cruises (*i.e.* after the "*Mila 36*" *Canal* had been dug), and the **k** values measured on sediment samples collected in the 1980 field trip. It must be mentioned that because of the emerged vegetation that had raided into the northwestern half of the Lungu Lake during the sampling campaign (July 2006), the depths not exceeding 1 m, this lake side was not reachable for collecting bottom sediment samples. This explains the lower level of the magnetic susceptibility values recorded for the sediments sampled from the *Lungu L.* in the 2006-II cruise (see Fig. 3) as compared with the results obtained in the other 10 investigation phases carried out in the period 1987 – 1998.

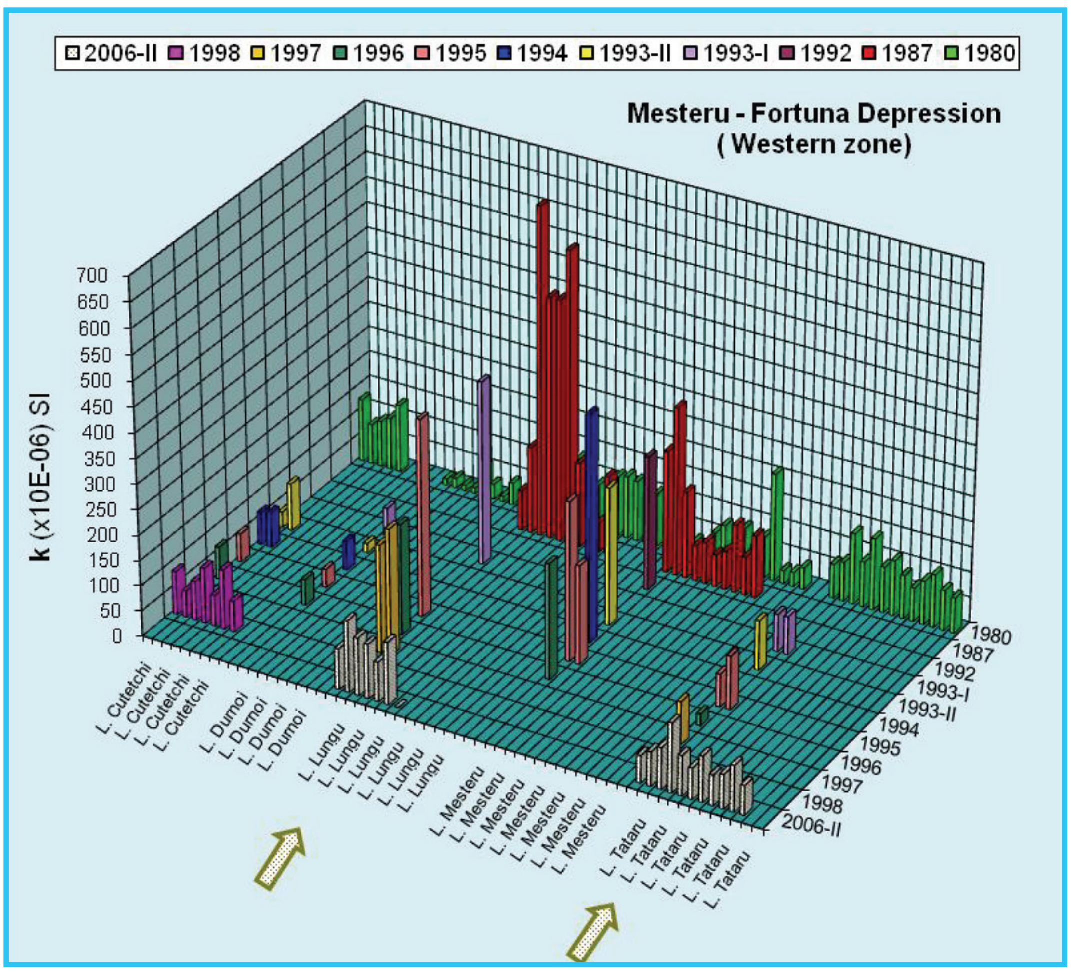


Fig. 3 The magnetic susceptibility of the bottom sediments sampled in the Lungu and Tătaru Lakes (marked by arrows), in the campaign carried out in July 2006 (*i.e.* 2006-II). *Note*: The **k** values are illustrated within a synoptic model together with the data obtained during the period 1980 – 1998 for 5 lakes from the western part of the Meşteru – Fortuna Depression.

In Fig. 4b, the vertical distribution of the **MS** values along the core DD 06-109, taken fom the *Lungu L.* (the core's location, in Fig. 4a), is illustrated; the calibration of the **MS** values to **k** scale (Fig. 2) is suggested, as well (Fig. 4b) (see also Rădan & Rădan, 2007b, in Rădan, 2008).

A zone of minimum susceptibility (with the lowest **k** value of 47.62×10^{-6} SI), assigned to the interval 3 – 5 cm (fine muds with vegetal fragments), is remarked, which is followed by a zone of maximum **MS**, with an apex defined by the **k** values of 192.46×10^{-6} SI, 196.84×10^{-6} SI and 195.40×10^{-6} SI, measured on sediments from the depth interval 11 – 20 cm (Fig. 4b).

3.2. Uzlina – Isacova area (Gorgova – Uzlina Depression)

An interesting case that was studied in the Gorgova – Uzlina Depression is related to the sedimentary environments associated with the *Uzlina* and *Isacova* "couple of lakes" (Fig. 1; Fig. 6a).

The synoptic pattern from Fig. 5, based on the sediments sampled in 17 cruises in the two coupled lakes, in the 1979 – 2006 interval (*e.g.* Rădan & Rădan, 2007d, in Rădan, 2008) shows the net difference between the measured magnetic susceptibility values: low and very low for the *Isacova L.*, characterised as a "*confined environment*", and much higher for the *Uzlina L.*, connected by a short canal to the *Danube River* and characterised by a "*dynamic environment*". Other several **MS** models (*e.g.* Rădan & Rădan, 2007d, in Rădan, 2008; Rădan & Rădan, 2009, 2010) can also be taken as proofs to argue this case; they confirm the net difference between the **k** values measured on the bottom sediments of the two coupled lakes, which simulates and actually evaluates the natural threshold existing between them, and the briskly water transit, respectively.

It must be emphasised that in all the cruises reaching the *Isacova Lake* during the 1979 – October 2006 period, no **k** value correlated with class **III** was measured on the bottom sediments collected with the grab samplers from this "relatively stagnant" aquatic environment (except for two **k** values determined for the sediments sampled in May 2006 from the mouths of two channels entering into the *Isacova L.*) (Fig. 5).

Besides, interesting **MS** data were achieved for a core taken from the central zone of the *Isacova Lake* (Fig. 6a), a sector crossed by the **k** isoline of 25×10^{-6} SI, which was marked on the magnetic susceptibility map (Fig. 6c), drawn up on the basis of the sampling stations network that was carried out in the first campaign in the area, in 1979 (the measured **k** values, in Fig. 5). The sediment sequence, described in the upper half of the core DD 06-161 (interval 0 – 26 cm) as porous and uncohesive muds with fine vegetal detritus or with rare shell fragments, provided **k** values assigned to lower class **II** (see Fig. 2), placed within a very narrow interval, *i.e.* 14.89×10^{-6} SI – 23.58×10^{-6} SI (Fig. 6b), with an average $\mathbf{k}_m$ value of 22.87×10^{-6} SI. The sediments sampled from the following interval, *i.e.* 26 – 34 cm, described as a coarser mud, is characterised by the **k** values of 27.21×10^{-6} SI and 58.20×10^{-6} SI (Fig. 6b), with an average magnetic susceptibility $\mathbf{k}_m$ = 42.71×10^{-6} SI, higher than for the upper sediment sequence, but also correlated with class **II** of the **k** scale (see Fig. 2). Finally, the lowermost sequence sampled within the interval 34 – 40 cm (Fig. 6b) and described as a coarse (fine sandy ?), porous, uncohesive mud, is consequently defined by higher **k** values (namely, 80.12×10^{-6} SI and 84.22×10^{-6} SI), which are assigned to class **III**.

On the other hand, related to the sediment samples collected at different intervals along the DD 06-161 core (40 cm long), taken from the central zone of the *Isacova Lake*, it's worth revealing the reliable correlation between the lithological description of the core sediments made on board of the research vessel and the magnetic susceptibility regime

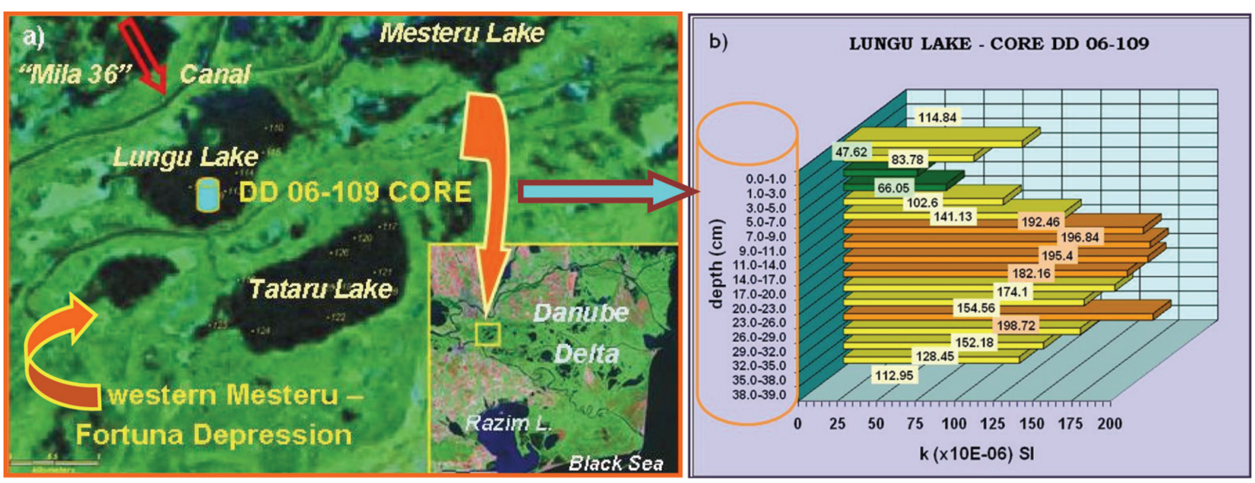


Fig. 4 The vertical distribution of the magnetic susceptibility (**MS**) along the DD 06-109 sediment core, taken from the Lungu Lake, Western Mesteru – Fortuna Depression. **a**) Location of the Western Meşteru – Fortuna Depression within the Danube Delta and of the sediment core in the Lungu Lake; **b)** 3-D bar chart showing the vertical distribution of the **MS** values along the sediment core.

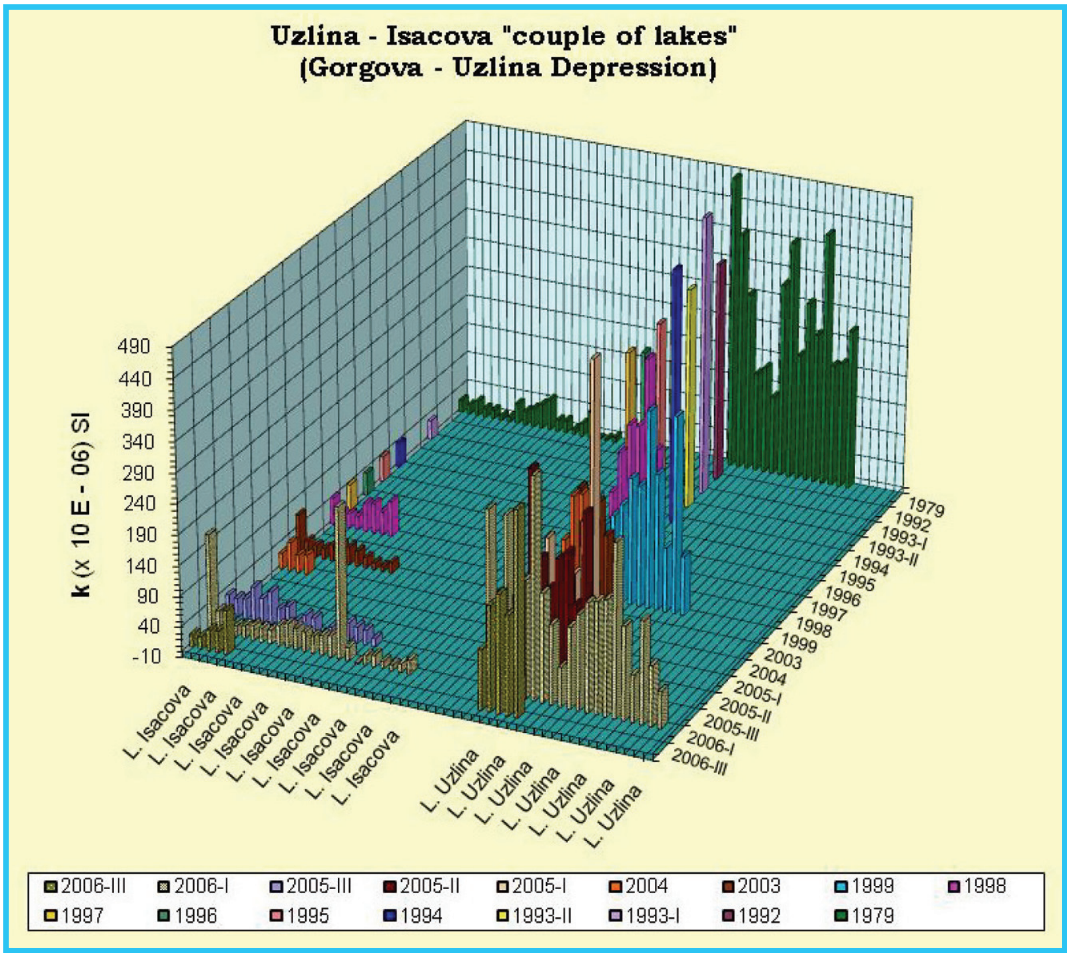


Fig. 5 Magnetic susceptibility of recent sediments sampled in 17 cruises (1979 – 2006) from the Uzlina – Isacova "couple of lakes".

determined in the laboratory. Apart from this, the reader can see in a recently published paper (Rădan & Rădan, 2009) a magneto-lithological model for bottom sediments collected with the grab sampler from the *Isacova* and *Uzlina lakes*, showing the correlation between the enviromagnetic parameter (**k**) and the lithological components (**TOM**, **CAR**, **SIL**). Strong negative correlations were shown by **k** *vs* **TOM** and **k** *vs* (**TOM**+**CAR**), and moderate negative correlations for **k** *vs* **CAR**, while **k** *vs* **SIL** is defined by a strong positive correlation.

3.3. Puiu – Roşu – Roşuleţ area (Lumina – Roşu Depression)

The lakes from this zone are placed in a distal position related to the direct fluviatile supplies and are situated in the Fluvio-Marine Delta Plain (Fig. 1).

There is a representative magnetic susceptibility (**MS**) data base, especially for the *Puiu*, *Roşu* and *Roşuleţ lakes*, resulted from the investigation of the recent sediments sampled in 17 cruises carried out during the period 1981 – 2010.

New results – based on the May 2009 campaign – concerning the integrated **MS**-lithological study of the sedimentary environments associated with these three lakes are here presented. The areal distribution of the **k** values (calibrated to the **MS** scale from Fig. 2), which were measured on the bottom sediments sampled in the *Puiu*, *Roşu* and *Roşuleţ* lakes, is illustrated in Fig. 7a,b. The magneto-lithological signatures recovered from the bottom sediments point out the predominance of the lower **k** classes **I**+**II** (55% + 38%; Fig. 7c), and of the **TOM**+**CAR** contents (65.8% + 7.23%), respectively; the remaining percents are assigned to the **k** class **III** (6%) and **IV** (1%) (Fig. 7c), and to the **SIL** content (26.97%), respectively.

A strong negative correlation was shown by **k** *vs* **TOM** (*i.e.* **r** = - 0.6575), whereas for **k** *vs* **SIL** a strong positive correlation (*i.e.* **r** = 0.6568) was determined (Fig. 8). Some specific examples are further presented.

In the *Puiu Lake*, the highest **k** values (*i.e.* 129.33×10^{-6} SI and 110.55×10^{-6} SI) were recorded for the samples collected in the discharge zone of the *Crişan – Caraorman Canal* (Fig. 7a), consisting of sandy mud to slightly muddy sand. The average mineral fraction content is 72.78%, while the organic material content is 22.54%. In the opposite situation are the sediments (vegetal organic muds and soft, noncohesive muds) taken from the northern zone of the *Puiu Lake*, which is at a greater distance from the emerged littoral ridges.

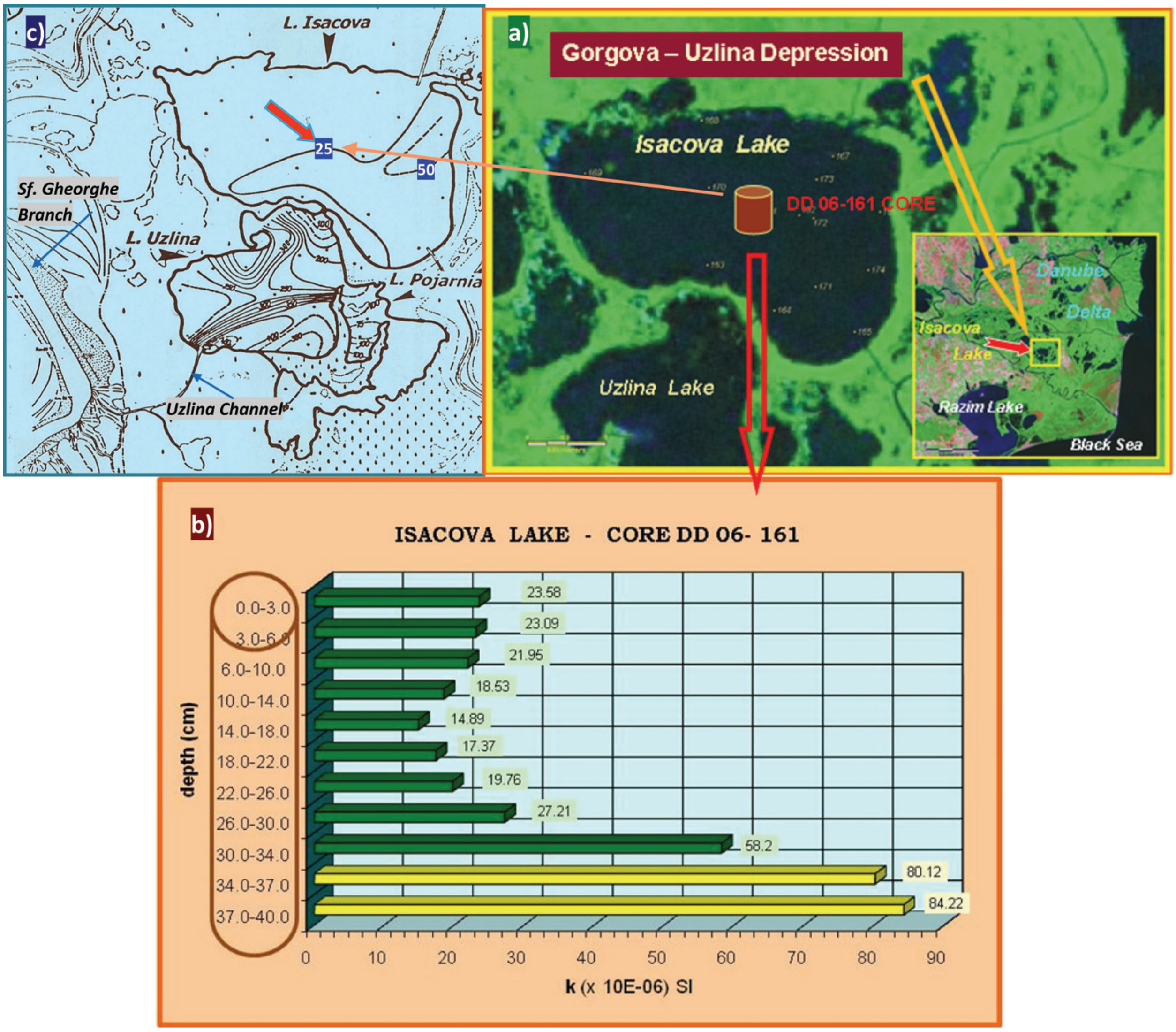


Fig. 6 The vertical distribution of the magnetic susceptibility (**MS**) along the DD 06-161 sediment core, taken from the Isacova Lake (Gorgova – Uzilna Depression). **a**) Location of the Gorgova – Uzlina Depression within the Danube Delta and of the sediment core in the Isacova Lake; **b)** 3-D bar chart showing the vertical distribution of the **MS** values along the sediment core; **c)** The magnetic susceptibility map drawn up for the bottom sediments sampled in the 1979 cruise. *Note*: The **k** values assigned to the **MS** isolines in the **k** map (**c**) must be multiplied by 10^{-6} (SI).

Consequently, low **k** values were measured (not higher than 14.34×10^{-6} SI), most of them being correlated with class **I** (Fig. 7a). The average organic matter content (**TOM**) of 78.11%, and the average mineral fraction content (**SIL**) of 14.79%, respectively, determined for the sediments collected from this zone, explain the measured negative **k** values and the other low **MS** values placed within the class **I** and class **II** lower part (Fig. 7a).

Similarly, in the *Roşu Lake*, the highest **k** values (*i.e.* 133.62×10^{-6} SI and 135.83×10^{-6} SI) were recorded for the bottom sediments (fine-medium grained sands and fine sandy muds) sampled in two stations from the mouth of the *Puiu – Roşu Channel* (Fig. 7b), which are well correlated with their lithological composition (*e.g.* an average mineral fraction content of 71.43%).

As regards the *Roşuleţ Lake*, excepting the **k** value of 192.52×10^{-6} SI calibrated to class **IV**, which was measured for the layer "b" (sandy muds) of the grab sample collected from the mouth of the *Sondei Canal*, close to the littoral ridge, the magnetic susceptibility of all the other bottom sediment samples (soft, noncohesive muds, generally rich in vegetal fragments) record values assignable to class **I** only (Fig. 7b). Actually, this lake is characterised by sediments rich in organic material (**TOM** – average content 75.05%, the sample taken from the canal mouth included). For carbonates (**CAR**), an average content of 6.08% was determined. Correspondingly, the mineral fraction content (**SIL**) is low, the average value being 18.87%.

It is worth pointing out that all these new results completed in 2009 confirm the magneto-lithological models

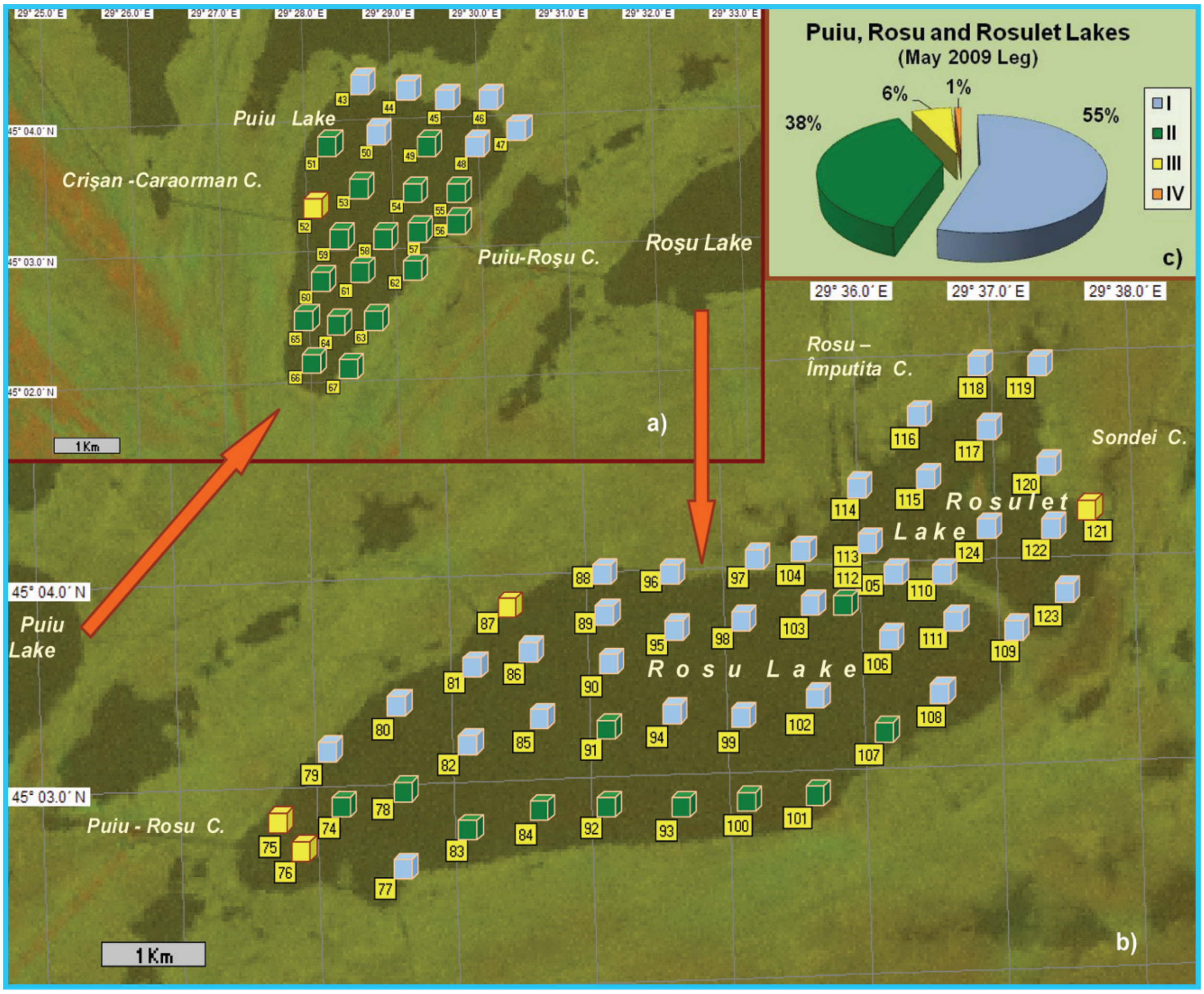


Fig. 7 Model showing the magnetic susceptibility (**MS**; **k**) characterisation of the bottom sediments sampled in the Puiu, Roşu and Roşuleț lakes (Lumina – Roşu Depression), in the 2009 campaign. **a), b)** areal distribution of the **k** values, correlated to the **MS** scale classes from Fig. 2; **c)** pie-diagram illustrating the **MS** classes (in percents) to which the lake sediments were calibrated. *Note*: In the (**a**) and (**b**) images, the average $\mathbf{k}_m$ values, calculated for the "a+b" layers of the grab samples, are taken into consideration, while in the image (**c**) all the **k** values (measured on each layer) are considered.

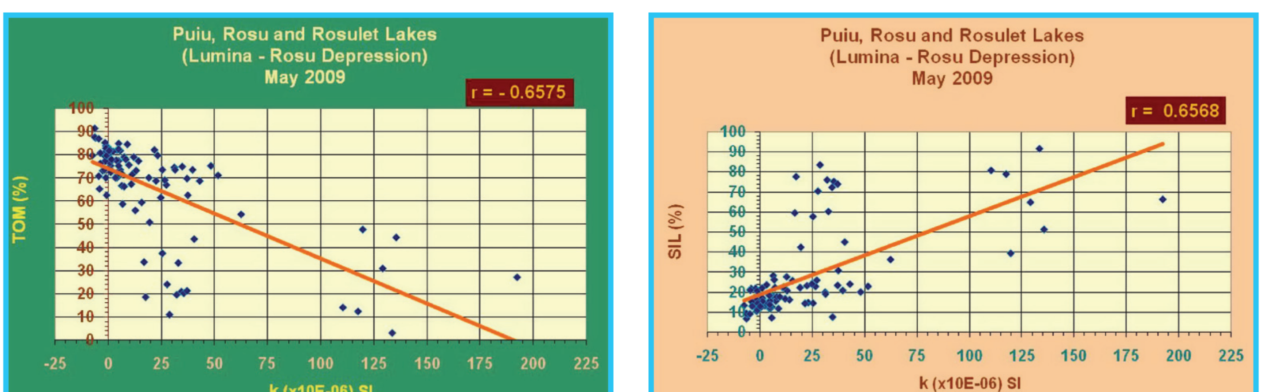


Fig. 8 Correlation between the enviromagnetic parameter **k** and the lithological components **TOM** (Total organic matter) and **SIL** (Siliciclastic-mineral fraction), determined for the bottom sediments sampled in the Puiu, Roşu and Roşuleț lakes (Lumina – Roşu Depression), in the 2009 campaign.

achieved on the basis of the bottom sediments that were sampled from the *Puiu*, *Roşu* and *Roşuleţ lakes* in the 2006 campaign (Rădan & Rădan, 2009).

Related to the integrated study carried out in 2006 in this zone of the Danube Delta, an example showing the vertical distribution of the magnetic susceptibility along two sediment cores is illustrated in Fig. 9. The core DD 06-160 (28 cm long) was taken from the *Roşu Lake* in 2006 (Fig. 9a). The average **k** values determined for the samples collected at different levels along the core are illustrated according to the colours which are assigned to the **k** classes of the magnetic susceptibility scale (Fig. 2). In the first 21 cm of the core, the sampled noncohesive, soft muds (possible carbonatic, with shell fragments, in the lower half of the specified interval), with H_2S smell, have provided very low **k** values, which were correlated to class **I** and class **II**-lower part (Fig. 9b). Instead, the samples (compact muds and coarse siltic muds) taken from the basal part reveal much higher **k** values, correlated to class **III** and class **IV** (Fig. 9b). The second sediment core (DD 06-160bis; 56 cm long), collected from the same location (Fig. 9a), confirms the sudden change of the **MS** values recorded at the 23 cm level (DD 06-160 core), in this case at 33 cm depth (Fig. 9c). The magnetic susceptibility regime recorded for the two sediment cores could be explained by the interception of an older sandy sequence in the the *Roşu Lake* sampling zone.

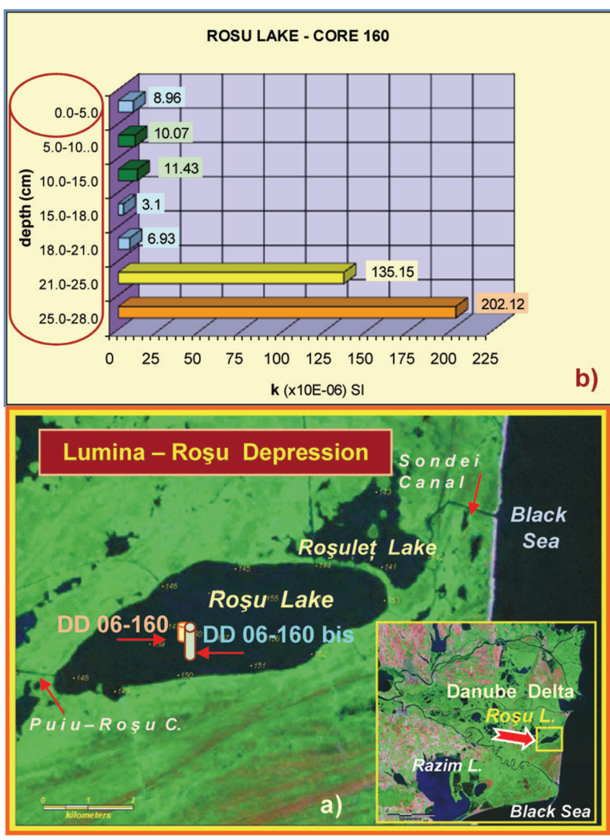
3.4. Matiţa – Poludionca – Merhei zone (Matiţa – Merhei Depression)

This area is far from the main distributaries of the Danube River (Fig. 1). The *Matiţa*, *Poludionca* and *Merhei lakes* (Fig. 10a) are protected from the direct fluvial influx, and consequently, not significantly affected by the Danube supplies. They are characterised by a more or less *confined sedimentary environment*, which is developing in a relatively stagnant aquatic area.

The magneto-lithological signatures recovered from the sediments sampled in 2006 in the most extended lake (*Merhei L.*) of the depression and from one of the smallest ones (*Poludionca L.*), actually an "annex" of the *Matiţa L.* (Fig. 10a), are here presented.

The new results concerning the magnetic susceptibility of the lake sediments are illustrated within a synoptic model in which all the existent data for the 1978 – 2006 period are included (Fig. 10b,c). The enviromagnetic fingerprint (**MS**) recovered from the bottom sediments of the three lakes remained almost undisturbed, in each of the analysed cases its intensity being calibrated to the lower classes (**I** and **II**) of the **MS** scale (Fig. 10c; see also Rădan & Rădan, 2010).

The slight changes which can be noticed relating to the *Matiţa Lake* in 2006 as compared with the previous data (Fig. 10b,c) are, anyway, within the range of the lower **k** classes **I** and **II** (*i.e.* within an interval defined by **k** values lower than



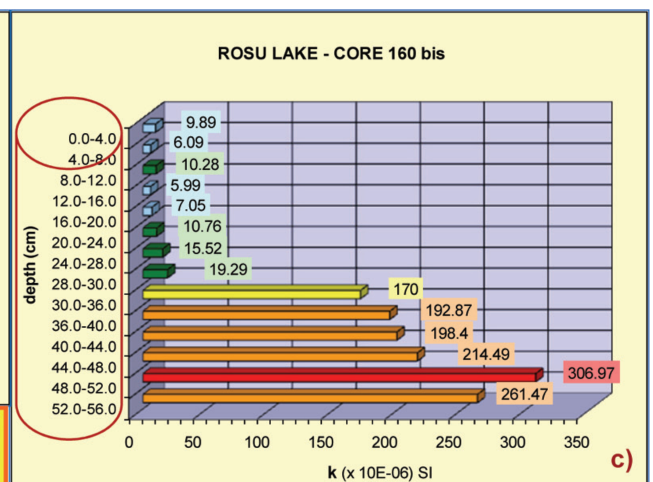
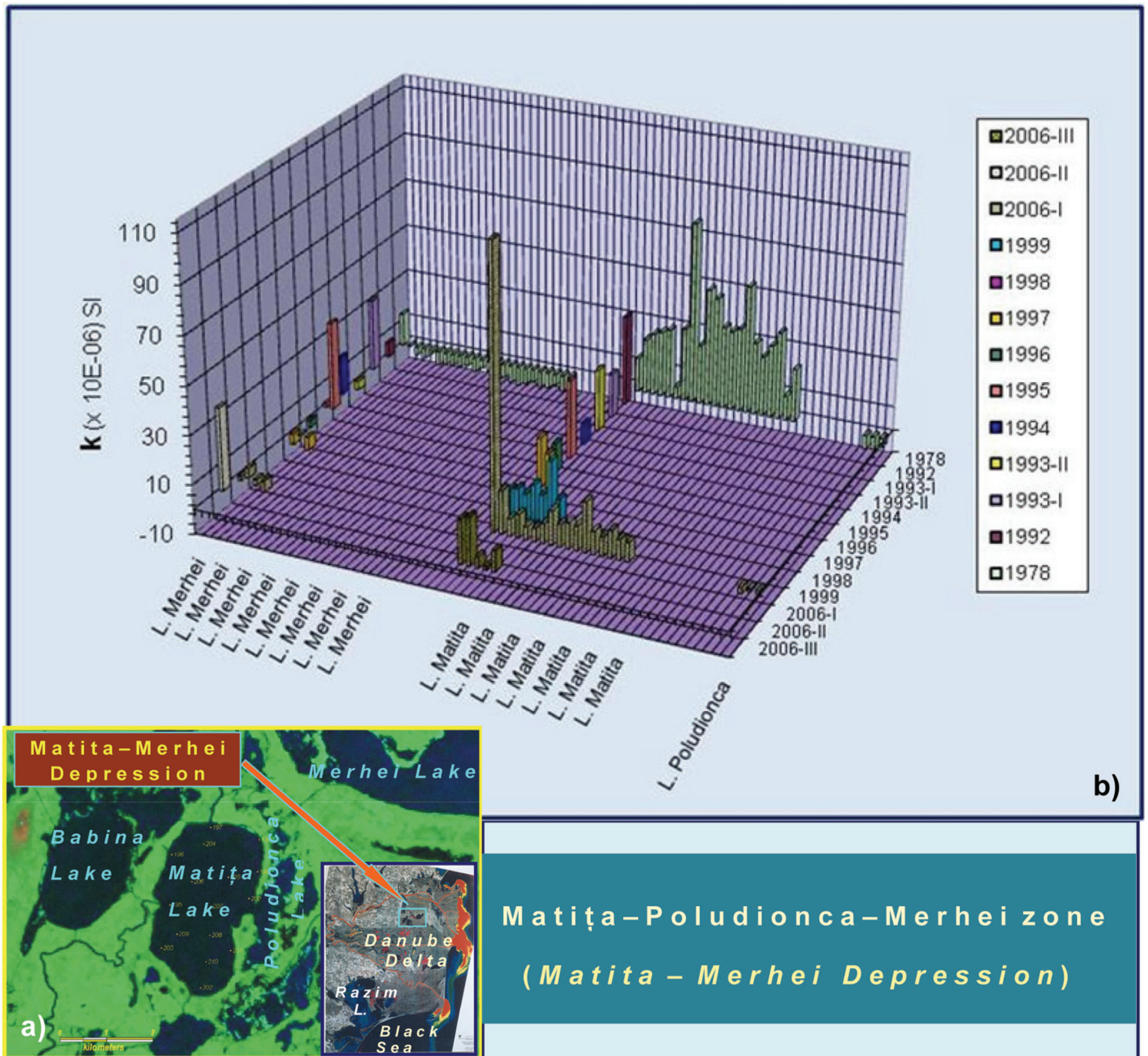


Fig. 9. The vertical distribution of the magnetic susceptibility (**MS**) along two sediment cores taken from the same location in the Roşu Lake (Lumina – Roşu Depression). **a)** Location of the Roşu Lake in the Danube Delta and of the two cores in the Roşu Lake; **b)** 3-D bar chart showing the vertical distribution of the **MS** values along the DD06-160 sediment core; **c)** 3-D bar chart showing the vertical distribution of the **MS** values along the DD06-160bis sediment core.



Cruises	1978						1992	1993		1994	1995	1996	1997	1999		2006							
Location (lakes)								I	II							I					II	III	
Merhei	II	I	I	I	I	I	I	II	I	II	I	I	I			I					II		
	I	I	I	I	I	I					II		I			I							
	I	I	I	I	I	I							I			I							
	I	I	I	I	I	I										I							
Matița	II	II	II	II	II	II	II	II	II	I	II	II	II	II	II	III	I	I	I	I		II	I
	II	I	II	II	II								II	II	II	II	I	II	I			II	
	II	II	II	II	II									II	II	I	I	II	II			I	
	II	III	II	II	II									II		I	II	II	I			I	
Poludionca	I		I		I											I		I		I			c)

Fig. 10. Magnetic susceptibility characterisation of the bottom sediments sampled in the Matița – Poludionca – Merhei zone (Matița – Merhei Depression, Danube Delta). **a**) Location of the investigated lakes; **b)** Synoptic 3-D column chart showing the **MS** data obtained in several cruises having been carried out since 1978; **c)** Table with the **k** classes to which the lake sediments were calibrated (by using the **k** scale from Fig. 2).

10×10^{-6} SI and not higher than 75×10^{-6} SI). The enviromagnetic parameter intensity change that is observed (from class **II** to class **I**) could suggest an enrichment in organic material of the *Matița Lake* sediments towards the end of the considered time interval. For more details the reader is referred to Rădan & Rădan (2009), where several magneto-lithological models are particularly presented and commented. For example, with regard to the sediments sampled from the *Matița – Poludionca – Merhei* zone in 3 cruises of 2006, the integrated study points out a strong correlation between the enviromagnetic parameter and the lithological components. The net predominance of the lower classes **I** and **II** (97%) is supported by a high organic component content within the bottom sediments, to which the carbonatic fraction is added (**TOM** + **CAR** = 75.8%). The calculated **r** coefficients show that the relations **k** *vs* **TOM** and **k** *vs* (**TOM**+**CAR**) are evaluated as strong negative correlations. Also, a strong but positive correlation characterises the relation **k** *vs* **SIL**.

4. CONCLUDING REMARKS

The results presented in the paper for various sedimentary environments, investigated in four representative zones located in both the Fluvial Delta Plain and Fluvio-Marine Delta Plain, demonstrate that the recent sediments fingerprinting in the Danube Delta lakes is feasible by using composite magnetic susceptibility (**MS**)-lithological signatures.

The variations of the **MS** values are in agreement with the macroscopic specification of the sediments collected with the grab samplers, performed on board of the research vessels (*i.e*. the primary lithological descriptions). Moreover, they are very well correlated with the laboratory data concerning the lithological composition of the collected samples (*i.e*. organic matter, carbonate and mineral-siliciclastic fractions, respectively).

The integrated **MS**-lithological study makes possible a quantifiable reasoning of the differentiation of the sedimentary environments which exist in the Danube Delta, and also of the sedimentation processes, clearly revealing the allochthonous sedimentation (predominantly detrital in the lacustrine ecosystems directly influenced by the Danube River) *versus* the dominantly autochthonous sedimentation present in the distal zones, in which the organic component predominates.

Recovering the magnetic fingerprints imprinted in the lake sediments, approaching the magnetic susceptibility distribution both in the horizontal and the vertical planes by means of the investigation of the grab samples, and the sediment cores, respectively, an useful and innovative contribution to the environmental and geoecological studies, as well as to the investigation of the hydrosedimentary processes, is reliable.

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