ECOHYDROLOGICAL APPLICATIONS IN SOUTHEASTERN ROMANIA WETLANDS BASED ON A MAGNETO-LITHOLOGICAL TOOL

SORIN-CORNELIU RĂDAN(1), SILVIU RĂDAN(2)

(1) Geological Institute of Romania, 1 Caransebeş St., RO-012271 Bucharest, Romania; e-mail: sc.radan@yahoo.com;
(2) GeoEcoMar, 23-25 Dimitrie Onciul St., RO-024053 Bucharest, Romania; e-mail: radan@geoecomar.ro

Abstract. Modern sediments have been sampled from the most important wetlands in the southeastern Romania, i.e. Danube Delta, Razim (Razelm) – Sinoie Lagoonal Complex and the Black Sea Littoral Zone. Composite models are illustrated and the correlations between the magnetic susceptibility (MS; k) values and the main lithological components (i.e. total organic matter/TOM, carbonate/CAR and mineral-siliciclastic/SIL, respectively) are analysed. The quality of proxy environmental parameter of the magnetic susceptibility to reveal distinguishing features for different lithological characters is discussed. Besides, the data show the connection with the distinct position of the lakes related to the fluvial supplies, to the hydrodynamic context or to the specific source-areas. Moreover, it is analysed how the changes of the ecohydrological conditions in the Western Meşteru – Fortuna Depression (by digging a new canal) or along a Danube Delta distributary (by cutting-off its meanders) are reflected by the enviromagnetic fingerprints recovered from the bottom sediments.

Key words: magnetic susceptibility, lake sediment, lithological components, environmental magnetism, ecohydrology, Danube Delta, Razim (Razelm) – Sinoie Lagoonal Complex, Black Sea Littoral Zone, wetland.

1. INTRODUCTION

The lake sediments have played a determinant role and have stimulated the start concerning the development of the environmental magnetism (Thompson et al., 1975, 1980, Oldfield et al., 1978, Verosub & Roberts, 1995, Dekkers, 1997, Evans & Heller, 2003).

The study of the modern sediments from three main aquatic areas of Romania, i.e. Danube Delta (DD), Razim (Razelm) – Sinoie Lagoonal Complex (RSLC) and the Black Sea Littoral Zone (BSLZ) (Fig. 1), is based on an integrated petromagnetic and lithological approach, resulting in a magnetic susceptibility (MS) characterisation of the different sedimentary environments from deltaic, lagoonal and littoral lakes. Besides, two cases from Danube Delta were chosen in order to exemplify the capability for ecohydrological applications of this enviromagnetic tool, which use magnetic susceptibility measurements on bottom sediments.

Based on the MS (k) values and the lithological components (i.e. total organic matter/TOM, carbonates/CAR and mineral-siliciclastic fraction/SIL), a number of magneto-lithological models are carried out for several important lacustrine ecosystems located in the most important wetlands of southeastern Romania (Fig. 1). Results obtained on bottom sediment collections taken from the Puiu – Roșu – Roșuleț zone (DD) in 2006 and 2009 cruises, and from the Razelm and Golovița area (RSLC) and the Tașaul Lake (BSLZ) in 2007 cruises (Fig. 1) are presented; very good correlations were shown by k vs TOM, k vs (TOM+CAR) and k vs SIL (negative – in the first two cases, positive – in the third one).

For other cases, the reader is referred to Rădan & Rădan, 2007, 2009, 2010a,b, Rădan & Rădan, 2007b,d, in Rădan, 2008, Rădan et al., 2008.
2. LOGISTICS, MATERIALS AND METHODS

There is a huge magnetic susceptibility data bank for the southeastern Romania wetlands, which was achieved during more than three decades. This is based on ca 2500 MS measurements on bottom sediments sampled in the Danube Delta and around 1750 k values for recent sediments from the Razim–Sinoie Lagoonal Complex, to which about 150 MS values obtained for modern sediments sampled from the Black Sea Littoral Zone, in 2007 and 2008, must be added (Rădan & Rădan 2006; Rădan & Rădan 2007a,b, in Rădan, 2008). The data that are analysed herein are mainly based on the collections taken during the cruises performed in the 2006 – 2009 period.

The field campaigns have been performed on board of the fluvial research vessel “Istros” (Fig. 2a) and the motor-boat “Mâniuco” (Fig. 2b), the latter being used in the lakes where the depths were very low (e.g. lower than 1.50 m).

To locate the sampling points, a high precision was ensured by “Simrad” radar, GPS and echosounder equipments, and by “Magellan – Meridian Color” portable GPS and “Eagle – Cuda-168” echosounder, respectively (Fig. 3).

The stations were located to allow for an uniform network of sediment sampling points within the lacustrine areas (two examples, in Fig. 4).

The sampling of bottom sediments was carried out using “Van Veen”-type grabs (Fig. 5a), which allowed to take relatively undisturbed (at the upper part) “sediment packets” (Fig. 5b). Besides, in 2009, a number of short sediment cores (less than 56 cm long) were taken from all the four main lakes of the lagoonal complex. In 2010, another 8 cores (up to maximum 57 cm) were sampled with the Hydro-Bios corer from 6 lakes of the Danube Delta.

A macroscopic description of the lithological constitution of the bottom sediments (Fig. 5b) was performed on board of the research vessels. The different levels identified within the “sediment packets” were marked “a”, “b”, “c” etc., and material from each sediment level was collected for different laboratory analyses, e.g. the magnetic susceptibility (MS) and the lithological components (i.e. total organic matter/TOM, carbo-
**Fig. 2** Research vessels used in the cruises in various lakes. **a)** Fluvial research vessel "Istres"; **b)** Motor-boat "Măriuca" (for shallow lakes).

**Fig. 3** Equipments used for location of the sampling stations and for water depth and temperature measurements. **a)** "Simrad" Radar-GPS-Echo-sounder equipment; **b)** "Eagle-Cuda-168" echosounder.

**Fig. 4** Distribution of the sampling stations for bottom sediments; examples: **a)** Razim and Golovița Lakes (Razim – Sinoie Lagoonal Complex); **b)** Tașaul Lake (Black Sea Littoral Zone).
nate/CAR and mineral-siliciclastic/SIL fractions). Ternary diagrams were drawn up to show the lithological classification of the bottom sediments.

The MS parameter was measured with a Kappabridge KLY-2 instrument in the laboratory of rock-magnetism and palaeomagnetism of the Geological Institute of Romania. The lithological components were determined in the geochemical laboratory of the Faculty of Geology and Geophysics, the University of Bucharest. To calibrate the lake sediments, a “Magnetic Susceptibility (k) Scale” (Rădan & Rădan, 2007; Fig. 6) was used. Numerous MS patterns were performed to analyse the characteristic magnetic signatures of the various sedimentary environments.

Several correlation coefficients (r) were calculated, e.g. related to k vs TOM, k vs CAR, k vs (TOM+CAR) and k vs SIL. Graphical correlation was also taken into consideration to show and interpret the connection between the enviromagnetic parameter and the lithological characters. A scale to evaluate the size of the correlation was used (Fig. 7).

A number of composite magneto-lithological models were carried out on the basis of the magnetic susceptibility values (k) and the contents of the lithological components (i.e. TOM, CAR, SIL) obtained for the lake sediments.

3. RESULTS AND DISCUSSION.
ECOHYDROLOGICAL APPLICATIONS

The specific enviromagnetic fingerprints recovered from the lake sediments are emphasised by various integrated k-TOM-CAR-SIL models. The established correlations between the magnetic susceptibility (MS; k) and the lithological components of the lake sediments favour the use of this enviromagnetic tool to carry out ecohydrological applications. Two cases from the Danube Delta are analysed in the second part of this chapter.

3.1. CORRELATION BETWEEN THE ENVIROMAGNETIC PARAMETER MS AND THE LITHOLOGICAL COMPONENTS OF THE LAKE SEDIMENTS AS A SUPPORT FOR ECOHYDROLOGICAL APPLICATIONS

Integrated magnetic susceptibility and lithological data obtained for a series of representative lakes from the three above mentioned wetlands are further analysed.

3.1.1. Deltaic wetlands

The main lakes from four zones of the Danube Delta (1, 2, 3, 4, in Fig. 1) were in attention for our complex study in 2006. Several MS-lithological patterns that illustrate the various cases of the “dynamic”, “confined” and “intermediate” deltaic environments located in the Fluvial Delta Plain and Fluvio-Marine Delta Plain are given in three recently published papers (Rădan & Rădan 2009, 2010a,b).

A conclusion of the previous studies was that the models associated with 10 deltaic lakes located within four DD depressions emphasise the allochthonous sedimentation, predominantly siliciclastic in the lacustrine ecosystems that are directly influenced by the River Danube, comparing with the dominantly autochthonous sedimentation in the distal zones, where the organic component is mostly present.

Four deltaic areas were investigated. The case of the Puiu – Roșu – Roșuleț zone (Fig. 8a), situated in the Lumina – Roșu Depression (3, in Fig. 1), is here presented, the lake sediments being sampled not only in 2006, but in May 2009, as well.

The magnetic susceptibility and the lithological models resulting from the investigation of the bottom sediments sampled in the 2006 cruise (Fig. 8b,c) reveal the predominance of the lower classes I+II (83%) (according to the k scale from Fig. 6; also, in Rădan & Rădan, 2007), and of the organic and carbonate components (TOM+CAR contents; 64.3%), respectively; the remaining percents belong to the intermediary class III (17%), and to the mineral fraction (SIL content; 35.7%), respectively. A strong negative correlation (r = -0.8502), according to the scale from Fig. 7, was shown by k vs (TOM+CAR), and a strong positive correlation (r = 0.8502) for k vs SIL (Fig. 8d).
The MS-lithological results obtained for the bottom sediments sampled in the 2009 cruise (Fig. 8e,f,g,h) confirm the above mentioned data (related to the 2006 cruise): the clear predominance of the lower k classes I+II (93%; Fig. 8e), and of the (TOM+CAR) contents (73%; Fig. 8f), respectively; the remaining percents belong to k classes III+IV (i.e. 6%+1%), and to the SIL component content (27%), respectively. A strong negative correlation (according to the scale from Fig. 7) was shown by k vs (TOM+CAR), and a strong positive correlation for k vs SIL (Fig. 8d,g,h).

Higher percentages were obtained for the MS values correlated to the classes III or (III+IV) and for the SIL component content recorded for the lake sediments sampled in 2006 as compared with the data (k; SIL) achieved for the sediment samples collected in 2009 (Fig. 8b,c,e,f). This result is explained by the different hydrological regime (and its influence on the sedimentary environments) relating to the two campaigns. In the spring 2006, due to the existing floods (at the same time, a very high flow of the Danube River), the detrital material discharge increased, so that the SIL content is higher (35.7%; Fig. 8c) than in 2009 (27%; Fig. 8f), and consequently, the k values assigned to the class III represent a higher percentage (17%; Fig. 8b) than of the MS values assigned to classes III+IV (7%; Fig. 8e) measured on the bottom sediments sampled in 2009.

So, the magnetic susceptibility fingerprints recovered from bottom sediments sampled in various lakes of the Danube Delta show suitable capabilities of this enviromagnetic tool for ecohydrological applications.

3.1.2. Lagoonal wetlands

In fact, the Razim (Razelm) – Sinoie Lagoonal Complex was the first aquatic area of Romania in which the capabilities of the magnetic susceptibility (MS) relating to the study of the lake sediments have been tested (e.g. Mihăilescu et al., 1983). The MS data bank comprises around 1750 k values measured on bottom sediment samples (cores included) collected from all the 4 main lakes of the lagoonal area (i.e. Razim/Razelm, Goloviţa, Zmeica and Sinoie lakes; Fig. 1). The data base was achieved during more than three decades and can be systematised relating to three important time periods in which the sediment samples were taken and investigated:
Fig. 8 Magneto-lithological model for bottom sediments sampled from three lakes (i.e. Puiu, Roșu and Roșuleț) in the Fluvio-Marine Delta Plain (Danube Delta; 3, in Fig. 1), showing the correlation between the enviro-magnetic parameter k and the lithological components (TOM, CAR, SIL).

1976 – 1978, 2002 – 2004, and 2007 – 2010. The lake sediments were calibrated to k scale (Fig. 6).

Here, the cases of the Razim (Razelm) L. and Golovița L. are briefly presented. Among a series of factors, the variations of the magnetic susceptibility are controlled by the sediment grain size, generally coarser than in the Danube Delta lakes; they are also influenced by the less significant contents of organic material and carbonates (excepting the Zmeica Lake case). At the lagoonal complex scale, an increasing weight of the sediments calibrated to k class II is noticed, in the direction Razim L. → Golovița L., accompanied by a corresponding decrease of the contribution of the k classes III, IV and V, in agreement with the lithological composition variations; the lake sediments are predominantly of mineral or mineral-organic type, rarely organic-mineral in the Razim L., and of organic-mineral type, subordinately organic-mineral, in the Golovița L. (see the ternary diagrams in Fig. 9).

A general model for the Razim (Razelm) – Sinoie Lagoonal Complex, referring to all the four lakes and covering the time intervals 1976 – 1978 and 2002 – 2004 is presented by Rădan & Rădan (2007d, in Rădan 2008); for Razim and Golovița lakes only, the results for the sediments sampled in 2007 are added as well.

As we have mentioned before, the present paper is focused on examples from the Razim and Golovița lakes (6 and 7, in Fig. 1). Some results based on magnetic susceptibility and lithological data obtained for modern sediments sampled during the 2007 cruise are presented in Figs. 9 and 10. Besides, in Fig. 9 are illustrated the k classes to which were calibrated the Golovița Lake sediments sampled at a 30 years
Fig. 9 Magneto-lithological model for bottom sediments sampled from Golovița Lake, located in the Razim – Sinoie Lagoonal Complex (7, in Fig. 1).
time interval (1977, and 2007, respectively; a larger collection was taken in the first cruise). As regards the latter campaign (2007), the MS-lithological cartographic models illustrated in Fig. 9 for the Goloviţa Lake reflect the coincidence between the sedimentation zones characterised by high \( k \) values and the areas outlined as dominantly siliciclastic. For example, the prolongation into the underwater area of an important sand ridge (i.e. Lupilor Ridge), which separates the southern lakes (Sinoie and Zmeica) of the lagoonal complex (Fig. 1), is pointed out by a zone of maximum values in the “Goloviţa” magnetic susceptibility map, particularly located in its eastern-southeastern part (Fig. 9e). This result confirms the clear MS anomaly that was mapped on the basis of the large collection of sediment samples taken for the first time from Goloviţa Lake, in 1977 (Mihăilescu et al., 1983; also, Râdan & Râdan 2007d, in Râdan, 2008, where another image version of the “Goloviţa – Razim” MS map is illustrated).

Additionally, the lithological composition of the recent sediments sampled during the 2007 cruise is here presented. A maximum anomaly is outlined in the mineral-siliciclastic content (SIL) map, in the same eastern-southeastern area of the Goloviţa Lake (Fig. 9f). That explains the higher \( k \) values measured on the bottom sediments sampled in the specified zone. Correspondingly, a minimum anomaly is shown by the Total Organic Matter content (TOM) map in the same sector (Fig. 9g). For similar patterns carried out for the Razim Lake, the reader is referred to Rădan et al., 2008; Rădan & Râdan, 2007d, in Râdan 2008; Rădan & Rădan, 2010b.
With regard to these two lakes (Razim and Golovița), a composite magneto-lithological model shows the explicit (graphical) correlation between the magnetic susceptibility \( k \) and the lithological components TOM (organic matter), CAR (carbonates) and SIL (mineral-siliciclastic content) (Fig. 10). Concerning the magnetic susceptibility \( (MS) \), the sediment samples are calibrated to \( k \) class III (79%), class IV (15%) and \( V_a \) (6%) \( (MS \) scale, inserted in Fig. 9), while the lithological components show contents of 41.6%, 7.4% and 51.0% for TOM, CAR and SIL, respectively. According to the scale from Fig. 7, the coefficients \( r \) suggest moderate negative correlations for \( k \) vs TOM and \( k \) vs \( (TOM+CAR) \), and a moderate positive correlation for \( k \) vs SIL (Fig. 10).

3.1.3. Littoral wetlands

The modern sediments of four lakes from the Black Sea Littoral Zone (Fig. 1) were investigated with regard to the magnetic susceptibility and the lithological composition, namely Tașaul, Siutghiol, Techirghiol and Mangalia. Some results achieved for the bottom sediments sampled from the first one during the 2007 cruise are here briefly presented as an example.

The particularities of the genesis and the aquatic environment evolution characteristics stand for the Tașaul L. \( (8, \) in Fig. 1) to be considered as representative for this last category of wetlands \( (i.e. \) littoral) under attention in the paper.

The total organic material \( (TOM) \), showing an average content of 62.7%, is the principal lithological component of the Tașaul Lake sediments. The carbonates (most probably of biochemical origin) have not an important contribution (4% average content). The siliciclastic component \( (SIL) \) content values are placed within a large definition range, but the average is relatively low (33.3%), confirming the predominance of rich in organic matter muds. The areal distribution of the TOM and SIL contents is shown in the corresponding maps in Fig. 11f,g, next to the magnetic susceptibility \( (k) \) map illustrated in Fig. 11e. The ternary diagram (Fig. 11j) points out the net preponderance of the organic component, followed by the siliciclastic one and the carbonate fraction, the latter with

![Fig. 11 Magneto-lithological model for bottom sediments sampled in the Tașaul Lake. Note: The arrows A and B show two zones of minimum values revealed by the magnetic susceptibility \( (k) \) map for correlation with the (spatial) coincident sectors from the TOM and SIL lithological maps. A parallel model relating to the zones of maximum values outlined in these maps is given in Rădan et al., 2008. For further explanations, see text.](image-url)
a small contribution. The most sediment samples belong to the organic-mineral muds; in the second position are placed the organic muds, followed by the mineral-organic muds. A sample only belongs to the mineral, net siliciclastic sediments (Fig. 11j).

The calibration to the magnetic susceptibility scale, which was carried out for the bottom sediments sampled in the Taşaul Lake in 2007, points out the predominance of the k class II (53%), followed by the class III (34%), IVa (11%) and IV (2%) (Fig. 11h). The MS results are in agreement with the above mentioned lithological data. Actually, the lowest k values (zones shown by the arrows A and B in Fig. 11) were provided by the samples collected from the places where the organic rich sediments are deposited (Fig. 11e,f); an important maximum k regime was particularly mapped within the river (Casimcea) discharge zone, well shown by the detrital component map (Fig. 11g).

3.2. Ecohydrological applications of the enviromagnetic tool in the Danube Delta

Firstly, a case study concerning some lakes from the Fluvial Delta Plain is analysed, followed up by a test carried out in a fluvial-deltaic area, particularly relating to a meandering distributary of the Danube Delta.

3.2.1. Changes of the ecohydrological conditions in the Western Mesteţu – Fortuna Depression and their enviromagnetic fingerprints recovered from bottom sediments

Thus, the deltaic areas of the Danube Delta are undergoing the cumulative effects of the human interventions on the Danube flow regime, the anthropogenic activities carried out around them and the interventions taking place even inside of these aquatic systems.

The case study under attention in the present paper concerns the latter situation. The area anthropogenically stressed is located within the western part of the north fluvial delta plain, between Chilia and Tulcea & Sulina Branches (Fig. 12).

This zone became strongly affected by the Danube water supply since 1983, when a short canal cut between the Tulcea and Chilia Branches was completed (i.e. Cn. “Mila 36”, shown by red arrows in Fig. 12b,c).

The influence of the anthropogenic activities on the sedimentary environments and ecosystems from the western zone of the Mesteţu – Fortuna Depression is reflected by the changes in the hydrologic system dynamics, as well as by the modifications (i.e. lithological, mineralogical and geochemical) in the quality of sediments that are deposited in this area. The example of the Lungu and Mesteţu Lakes is the clearest in

Fig. 12 Location of the Canal “Mila 36” within the Western Mesteţu – Fortuna Depression. a) location of the western Mesteţu Depression within the Danube Delta; b) location of the “Mila 36” Canal related to the Lungu, Mesteţu and Tătaru Lakes; c) location of the “Mila 36” Canal related to the above mentioned lakes and to the Tulcea Br. and Sulina Br. (i.e. Danube Delta branches).
Fig. 13 Magnetic susceptibility (MS; k) patterns showing the MS distribution in two main lakes from the Western Meșteru – Fortuna Depression. a) k map (1980 cruise); b) k map (1987 cruise). Note: the MS values must be multiplied by $10^{-6}$ (SI); c) k values for sediments sampled in the Lungu L. (northern and southern zones) and Meșteru L. (western and eastern zones) before (i.e. in 1980) and after (i.e. 1987) the human intervention in the area (hydrotechnical works).
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The magnetic susceptibility measured on bottom sediment samples collected from the Lungu and Meșteru Lakes during the 1980 cruise (Fig. 13a,c) showed \( k \) values as high as \( 137 \times 10^{-6} \) SI (with an exception, locally explained). The sediments sampled in the two lakes during the 1987 cruise, that is after the “Mila 36” Canal was dug up (in 1982-1983), yielded \( k \) values up to \( 654 \times 10^{-6} \) SI for the Lungu L., and up to \( 334 \times 10^{-6} \) SI for the Meșteru L. (marked by red ovals in Fig. 13b; see, also, Fig. 13c).

A confirmation of the modified magnetic signatures, in keeping with the changes of the ecohydrological conditions followed up by those of the sedimentary environments, resulted from the MS monitoring cruises carried out during 1992-1997, as well as from the expedition organised in 2006 in the Lungu L. (and also in Tătaru L.; Fig. 14). Consequently, according to the \( k \) Scale, the MS signatures identified in 1980 in the Lungu and Meșteru Lakes are characterised by \( k \) classes II and III (with the exception above mentioned, i.e. a \( k \) value assigned to class IV) (Fig. 14a,b).

As concerns the 1987-1997 period, the MS calibration of the sediments shows obvious changes. Thus, for the Lungu L. (closer to the “Mila 36” Cn. inflow mouth; see Fig. 12b,c), 60% of the \( k \) values are defined by high \( k \) classes \( (\text{IV, Va, Vb}) \), while 40% by the classes II and III (Fig. 14a); see also Fig. 14a). In 2006, the sampling stations were placed in the eastern – south-eastern part of the Lungu Lake, an area less exposed to the fluvial inflow than the northern one (see Fig. 12b,c); the \( k \) values are defined between \( 78.22 \times 10^{-6} \) – \( 226.34 \times 10^{-6} \) SI (assigned to \( k \) classes III and IV; Fig. 14a). With regard to the Meșteru L. (1987-1996), the percentages are equally attributed to the classes II and III (50%) and to the higher classes IV.
and $V_s$ (50%; Fig. 14b; see also Figs. 14b and 13a,c to compare with the data obtained in the first cruise-1980).

This indicates that the deltaic environments of the Lungu and Meșteru Lakes are under anthropogenic pressure, induced by the hydrotechnical works, relating to the “Mila 36” Canal (shown by red arrows in Fig. 12b,c), dug up between the Tulcea and Chilia Branches, for economical reasons.

The sedimentary environments from the both lakes before digging the Canal “Mila 36” (i.e. before 1982-1983) and afterwards were characterised by means of MS measurements made on bottom sediments, and consequently differentiated. In the latter case, the sedimentary environments were modified as a reply to the intervention of the anthropogenic activities inside the deltaic ecosystems. The “magnetic susceptibility fingerprint” identified in the bottom sediments sampled from the Lungu L. and Meșteru L., in 1980, is defined by $k$ values placed totally and up to 92%, respectively, within the classes II and III of the MS scale (Fig. 14a4,b4).

According to the environmental changes in the area caused by the digging of the “Mila 36” C, resulting in a modification of the ecohydrological context as well, the MS fingerprint suffered an essential transformation. In the sedimentary environments of the two lakes, which became “dynamic” due to the intense Danubian supplies, in the bottom sediments sampled in 1987 and in different phases in the time period 1992-1997, an enhanced MS fingerprint was deciphered, which is defined by $k$ values belonging to the classes IV and V of the MS scale from Fig. 6 (also, Fig. 14c3).

The third lake under MS monitoring, i.e. the Tătaru L. (Fig. 12b,c), has not undergone important changes after the severe modification of the ecohydrological conditions in the area; its spatial position (relating to the Lungu L. and the Draghilea Chn.; Fig. 12b,c) made possible a double protection against the direct Danubian supplies. The magnetic signatures identified in the Tătaru L. sediments in 1980, 1993-1997 and 2006 keep the same characteristics; they are calibrated to $k$ classes II and III (100%; Fig. 14c5,c3,c1; see also the $k$ map related to the first cruise-1980 (Fig. 13a)). However, a transfer of the class III percentage weight towards the class II is noticed, which could reflect a slight increase of the organic matter content within the sediments during 26 years. This is the case of an “intermediary” type aquatic environment.

The ternary diagram from Fig. 15, showing the lithological classification of the sediments sampled in the Lungu and Tătaru Lakes in 2006, points out the distinguishing features recorded for the two lakes due to their different positions related to the fluvial supplies. The differences existent with regard to the lithological composition are clearly reflected by the enviromagnetic parameter (MS).

We finish the presentation of this case study on the ecohydrological applications of the environmental magnetism tool with a pattern showing the synoptic images of the

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**Fig. 15** Lithology of recent sediments sampled in 2006 from the Tătaru and Lungu lakes, with and without protection, respectively, related to the Canal “Mila 36”, which changed the ecohydrological conditions within the aquatic environments in the Western Meșteru – Fortuna Depression.
MS fingerprints identified within the lake sediments of the Western Meșteru – Fortuna Depression for 3 intervals: 1980 (Fig. 16a) – before the intervention of the human activities on the aquatic ecosystems; afterwards, between 1987-1997 (Fig. 16b), and in 2006 (Fig. 16c), respectively. The k maps are based on the average MS values calculated for all the samples measured for each lake, and are coloured according to k scale from Fig. 6.

After the “Mila 36” C. was dug up, the intensities of the MS fingerprints were modified, showing dynamic sedimentary environments, directly controlled by the riverine supplies. In the Lungu and Meșteru lake sediments, the intensity is increasing by two k classes (from III to V, and from II to IV, respectively; Fig. 16a,b), while in the Tătaru Lake it keeps the same (calibrated to class III; Fig. 16a,b,c) (some explanations were previously presented).

Another ecohydrological application of the enviromagnetic tool regards one of the Danube Delta Branches.

3.2.2. Modifications of the ecohydrological regime within the fluvial-deltaic aquatic environments: cutting-off the meanders of the Sf. Gheorghe Danube distributary; sedimentogenetic and enviromagnetic consequences

The Sf. Gheorghe Branch (5, in Fig. 1), characterised by a very sinuous, meander belt water flow, suffered important modifications. The human intervention by cutting-off 6 loops in order to improve the navigation conditions, the distance between Tulcea and Sf. Gheorghe localities being shortened from 108 km to 70 km, resulted in the discharge growth, by increasing the slope. The intervention on the hydrological regime, followed up by the changes of the environmental conditions in the aquatic ecosystems, influences also the sedimentary environments by lithological, mineralogical and geochemical modifications. More details regarding the dynamic morphology and the hydrosedimentary behaviour of this important delta meandering distributary could be found in a recently published book (Tiron, 2010); the role of the meander cut-offs canals and their effects on the sediment fluxes are particularly analysed.

In this context, it is very interesting and useful to test and evaluate the capability of the magnetic susceptibility technique as an enviromagnetic tool to be used for ecohydrological applications. This study is based on the data provided by two cruises organised in some sectors of the “free meandering segment” (km 90 – km 22). The two sampling campaigns were carried out in different environmental conditions: the first one – during a period with an extremely low-water level of the Danube River at the end of summer – beginning of autumn 2003, and the second one – during the high-water level in the spring 2004.

The first investigated fluvial-deltaic profile includes the most important meander of the Sf. Gheorghe Branch (A, in Fig. 17; between the former km 85 – km 65). Another sector which was investigated is located downstream, between km 38 – km 29 (B, in Fig.17). The sediments from the latter zone were sampled during the first cruise only (in 2003). The meander cutting intervention resulted in decreasing the water and sediment circulation on the loops, leading to some siltup processes, which mainly occur at the upstream meander ends. The cut-off meanders are going to become “oxbow” type lakes (similar to the Erenciuc and Belciug lakes from the Danube Delta).

The Danube bottom sediments are usually coarser, being represented by sands, deposited in fluvial conditions. The lithological analysis of the sediments from the meanders of the Sf. Gheorghe Branch emphasises a series of modifications of the general pattern, which clearly reflect the human impact on the river watercourse. Thus, on the first meander, the sediments sampled at the km 85 (Fig. 17: A), upstream of the cut (DD03-93 – DD03-95), consist in sands, which is a normal situation for the principal watercourse of the Danube. The

Fig. 16 Synoptic maps with the intensities of the magnetic susceptibility fingerprints (calibrated to the k scale from Fig. 6) identified in the lake sediments sampled in the Western Meșteru – Fortuna Depression, in two periods with different ecohydrological conditions in the area (see the text).
associated fauna is represented by living specimen or shells of Dreissena, Corbicula, Cepaea, Theodoxus, Hydrobia. Downstream, at the middle of the canal which shortens the meander (sample DD03-96), the erosion process is stronger than the deposition one, so that at the bottom appear only the old compacted clayey-siltic deposits, in which the waters continue to dig up, deepening the canal. Even downstream, at the km 64, immediately after the canal end (samples DD03-97 – DD03-99), the sediments are quite heterogeneous, reflecting both the material washed from the canal basement (fragments and pebbles of compacted clay) and the normal fluviatile sediment (i.e. sand), transported from upstream of cut. As regards the left bank, the sediments are associated with a muddy matrix. The fauna is reduced, dominated by Dreissena, at which scarce Cepaea şi Planorbis specimens are added.

The magnetic susceptibility correspondingly reflects the lithological observations above specified. Thus, the k values measured for the DD03-93 – DD03-95 samples (sands) are the highest among the 16 samples which were measured in the stations placed on the main meander, being calibrated to the k classes \( V_d \), \( V_c \), and \( V_a \) (see the k scale in Fig. 6). Actually, DD03-93 and DD03-95 are the only samples collected from the entire profile (the two meanders) which showed k values calibrated to the classes \( V_d \) and \( V_c \): 1761.18×10^{-6} \text{ SI}, and 760.48×10^{-6} \text{ SI}, respectively (Table 1).

On the other hand, for the DD03-96 sample, collected from the clayey-siltic deposits, a smaller k value was recorded, assigned to class \( V_d \) (201.55×10^{-6} \text{ SI}; Table 1). If we analyse the composition of the cut meander sediments, upstream downstream, we observe a clear trend towards a finer grain size, according to decreasing of the transport agent power. The upstream sediments, even they are already muds, have an important sandy component (DD03-92 – DD03-88). An exception is the sample DD03-91, collected at km 63, where a non-deposition zone appears, with a basement consisting of clay in the right bank which is exposed to the erosion. The mentioned sample is characterised by a magnetic susceptibility assigned to class \( V_d \), namely 142.18×10^{-6} \text{ SI} (Table 1).

Downstream, the dominant sediments are the organic mineral muds (DD03-87 – DD03-84), gray-blackish, with bioturbations, similar to those from some lakes inside the delta. The fauna gets lacustrine trends as well, by the abundance of the Unio, Anodonta and Viviparus specimens, next to the previously mentioned genera relating to the branch.

The magnetic susceptibility reflects well the trend of sediments to pass towards a finer grain size, upstream downstream. Even the MS is defined within the class \( V_d \) only, the samples DD03-92 – DD03-88 (excepted DD03-91, above explained), which were collected upstream, are characterised by higher k values (i.e. 286.15×10^{-6} – 415.61×10^{-6} \text{ SI}, with the average value \( k_m = 360.71×10^{-6} \text{ SI} \)) than the samples that were taken downstream (i.e. DD03-87 – DD03-84), for which the MS interval is 278.18×10^{-6} – 336.33×10^{-6}, with \( k_m = 296.05×10^{-6} \text{ SI} \) (Table 1).

The study carried out in the main meander area in the second phase, in 2004, showed again that the measured k
Table 1. Values of the magnetic susceptibility ($k$), correlated to the $k$ scale classes, for bottom sediments sampled from two cut meanders (A and B, in Fig. 17) of the Sf. Gheorghe Branch, during the 2003 cruise.

<table>
<thead>
<tr>
<th>Location (km)</th>
<th>Sample</th>
<th>Magnetic susceptibility $k$ [$10^{-6}$ SI]</th>
<th>$k$ Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sf. Gheorghe Branch (meanders)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>km 29</td>
<td>DD 03-100</td>
<td>206.04</td>
<td>IV</td>
</tr>
<tr>
<td>+ km 30</td>
<td>DD 03-101</td>
<td>369.93</td>
<td>Va</td>
</tr>
<tr>
<td>+ km 34</td>
<td>DD 03-102</td>
<td>302.86</td>
<td>Va</td>
</tr>
<tr>
<td>+ km 37</td>
<td>DD 03-103</td>
<td>350.17</td>
<td>Va</td>
</tr>
<tr>
<td>km 38</td>
<td>DD 03-104</td>
<td>196.97</td>
<td>IV</td>
</tr>
<tr>
<td>(immediately after the canal end; see Fig. 17)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>km 64</td>
<td>DD 03-97</td>
<td>408.13</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 03-98</td>
<td>338.54</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 03-99</td>
<td>324.96</td>
<td>Va</td>
</tr>
<tr>
<td>km 65</td>
<td>DD 03-84</td>
<td>285.43</td>
<td>Va</td>
</tr>
<tr>
<td>(Sf. Gheorghe Branch)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>km 70</td>
<td>DD 03-87</td>
<td>336.33</td>
<td>Va</td>
</tr>
<tr>
<td>km 75</td>
<td>DD 03-88</td>
<td>415.61</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 03-89</td>
<td>370.08</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 03-90</td>
<td>286.15</td>
<td>Va</td>
</tr>
<tr>
<td>+ km 81</td>
<td>DD 03-91</td>
<td>142.18</td>
<td>III</td>
</tr>
<tr>
<td>+ km 85</td>
<td>DD 03-92</td>
<td>370.98</td>
<td>Va</td>
</tr>
<tr>
<td>(Sf. Gheorghe Branch)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>½ cut</td>
<td>DD 03-93</td>
<td>1761.18</td>
<td>III</td>
</tr>
<tr>
<td>(middle of the canal; between km 85 and km 65)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DD 03-94</td>
<td>543.81</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>DD 03-95</td>
<td>760.48</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>DD 03-96</td>
<td>201.55</td>
<td>IV</td>
</tr>
</tbody>
</table>

Table 2. Values of the magnetic susceptibility ($k$), correlated to the $k$ scale classes, for bottom sediments sampled from the main meander cut-off of the Sf. Gheorghe Branch, during the 2004 cruise.

<table>
<thead>
<tr>
<th>Location (km)</th>
<th>Sample</th>
<th>Magnetic susceptibility $k$ [$10^{-6}$ SI]</th>
<th>$k$ Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sf. Gheorghe Branch (main meander)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>km 66+700</td>
<td>DD 04-12a</td>
<td>237.08</td>
<td>IV</td>
</tr>
<tr>
<td></td>
<td>DD 04-13a</td>
<td>246.52</td>
<td>IV</td>
</tr>
<tr>
<td></td>
<td>DD 04-13b</td>
<td>279.39</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 04-14a</td>
<td>243.64</td>
<td>IV</td>
</tr>
<tr>
<td>km 70</td>
<td>DD 04-14b</td>
<td>245.39</td>
<td>IV</td>
</tr>
<tr>
<td>km 75</td>
<td>DD 04-15</td>
<td>253.14</td>
<td>IV</td>
</tr>
<tr>
<td></td>
<td>DD 04-16</td>
<td>327.64</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 04-17a</td>
<td>303.89</td>
<td>Va</td>
</tr>
<tr>
<td>km 78+900</td>
<td>DD 04-18a</td>
<td>382.14</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 04-18b</td>
<td>361.64</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 04-19a</td>
<td>360.64</td>
<td>Va</td>
</tr>
<tr>
<td>km 85 (Sf. Gheorghe Br.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>km 78+900</td>
<td>DD 04-19b</td>
<td>433.64</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 04-20a</td>
<td>388.89</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 04-20b</td>
<td>438.89</td>
<td>Va</td>
</tr>
<tr>
<td>km 85</td>
<td>DD 04-21a</td>
<td>343.89</td>
<td>Va</td>
</tr>
<tr>
<td>(Sf. Gheorghe Br.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>km 85</td>
<td>DD 04-21b</td>
<td>157.27</td>
<td>III</td>
</tr>
<tr>
<td>km 85</td>
<td>DD 04-22</td>
<td>406.89</td>
<td>Va</td>
</tr>
<tr>
<td></td>
<td>DD 04-23a</td>
<td>379.14</td>
<td>Va</td>
</tr>
<tr>
<td>km 85</td>
<td>DD 04-23b</td>
<td>355.39</td>
<td>Va</td>
</tr>
<tr>
<td>km 85</td>
<td>DD 04-24</td>
<td>129.64</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>DD 04-25</td>
<td>665.64</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>DD 04-26</td>
<td>339.52</td>
<td>Va</td>
</tr>
</tbody>
</table>
values are within the normal limits for the Danubian sediments (generally, higher than $200 \times 10^{-6} \text{ SI}$) and does not record spectacular variations (Table 2). The downstream sediments are situated within the class IV of the k scale from Fig. 6 (with an exception, a value assigned to class $V_a$; but very close to the higher limit of the class IV). The sediments from the median sector and from the upstream zone are grouped within the classes $V_a$ and $V_b$ (with two exceptions in class III).

It is clearly observed an increasing trend of the magnetic susceptibility values (Table 2) from downstream (DD04-12; $k = 237.08 \times 10^{-6} \text{ SI}$) upstream (DD04-025, with $k = 865.64 \times 10^{-6} \text{ SI}$; DD04-026, with $k = 339.52 \times 10^{-6} \text{ SI}$), according to the increase of the sediment grain size (with some exceptions, easily to be explained).

Thus, the samples DD04-21b ($k = 157.27 \times 10^{-6} \text{ SI}$; Table 2) and DD04-24 ($k = 129.64 \times 10^{-6} \text{ SI}$) show lower MS values within a zone defined by high susceptibilities. The first sample is a finer mud (sediment layer "b"); representing an older mud, which was previously deposited relating to the sand from the sediment layer "a" (probably, during a period characterised by low waters and powerless water-courses). The second sample (i.e. DD04-24) is a more special sediment, namely fluffy clay pebbles, deposited in a zone with strong water flow, where the sand was washed. Instead, the highest k value which was recorded for the sample DD04-13b ($k = 279.39 \times 10^{-6} \text{ SI}$; Table 2), and also the quite high level of the susceptibilities measured on all the samples collected downstream could indicate a pollution trend within the sediments from the meander downstream, in the sector where the fine sediments are accumulated. As this zone is the most exposed to the anthropogenic pressure, taking into consideration the close touristic facilities and the associated intensive traffic, a contamination of the sediments, which is reflected by the high values of the magnetic susceptibility, is not excluded.

This situation was remarked in the previous cruise, as well (in 2003), so that the use of other analysis techniques, e.g. for heavy metals, is recommended in order to confirm the metallic pollution trends of the fine sediments from the meander sector situated between the mouth of the Uzina Channel (shown by a purple arrow, in Fig. 17) and the km 64.

As regards the second meander, which was investigated in 2003 only (B, in Fig. 17; samples DD03-100 – DD03-104, in Table 1), there can be noticed the same trends of passing from coarser sediments, i.e. muddy sands and sandy muds (samples DD03-102 – DD03-104) towards finer sediments, i.e. silty muds (DD03-101). The fauna is poorly represented. Here, also, at the downstream end of the cut, on the branch, it appears a sector with a strong erosion, with a basement consisting of clay (DD03-100); this sample records a lower value of the magnetic susceptibility ($k = 206.04 \times 10^{-6} \text{ SI}$), assigned to class IV (Table 1).

The magnetic susceptibility data which were obtained on the fluvial-deltaic profiles carried out in two sectors of the "free meandering segment" along the Sf. Gheorghe Branch, namely between km 85 – km 65 and km 38 – km 29 (Fig. 17), where the meanders were cut-off, can be also analysed by means of the patterns from Fig. 18. To the pie-diagram with the MS data associated with the two meanders (Fig. 18b; see also Tables 1 and 2), two synoptical pie-diagrams are added (Fig. 18a,c); the first (Fig. 18a) is based on the $k$ values measured for the bottom sediments sampled during 15 phases of the geoeological monitoring carried out between 1992 – 1998, 2003 and 2004-campaigns I and II; the second (Fig. 18c) is based on the same data as previously mentioned to which the $k$ values measured on the sediments sampled from the two meanders in 2003 and 2004 (2003-M and 2004-M, in Fig. 18c) were added.

The $k$ values are predominantly situated within the higher classes V and IV in all the studied cases. Thus, with regard to the sediments sampled from the two meanders (A, B, in Fig. 17), in 2003 and 2004, the k classes $V_a$, $V_b$, $V_c$ and $V_d$ are defined by 94% of the MS values, the remaining 6% being the susceptibilities assigned to class III (Fig. 18b). We remark that no monitoring sampling station was located within the former km 85 – km 65 and km 38 – km 29. In the pie-diagram from Fig. 18a, it can be noticed that 83% of the magnetic susceptibilities are assigned to class V (all the 4 sub-classes $V_a$, $V_b$, $V_c$ and $V_d$; see the k scale in Fig. 6); the remaining are correlated to class IV (14%) and III (3%). In the pie-diagram from Fig. 18c, 79% of samples show susceptibilities assigned to class V (all the 4 sub-classes), 17% – to class IV and 4% – to class III. It is noticed a slight decreasing of the weight of the $k$ values situated within the class V, and correspondingly, a transfer of 3% towards the class IV and 1% towards the class III. Therefore, the decreasing trend of the weight of the sub-classes $V_a$, $V_b$, $V_c$ and $V_d$ and the increasing trend of the percentages associated with the classes IV and III – aspect which was above argued – are in agreement with the hydrosedimentary processes taking place on the cut meander streams.

Finally, in the synoptic model from Fig. 19, the much higher intensities determined for the magnetic fingerprints of the fluvial-deltaic environments of the Danube Branches (i.e. Chilia, Tulcea, Sulina, Sf. Gheorghe distributaries), as compared with those detected in the lake sediments (e.g. Fig. 8, Fig. 14; also, Rădan & Rădan, 2009), are remarked. The most samples, collected from the bottom sediments of the Danube Delta distributaries, during two time intervals (1992 – 1998 and 2003/2004 – 2007), recorded magnetic susceptibilities assigned to the highest classes ($V_a$, $V_b$, $V_c$; $V_d$), namely 84% – Chilia Branch, 75% – Tulcea Br., 54% – Sulina Br., 83% – Sf. Gheorghe Branch. No MS values were assigned to the lower classes I and II (Fig. 19), which is a normal situation, taking into consideration that the sediments of the Danube Delta Branches consist of sands, primarily, with a variable grain size. Hence, the capability of the commented enviromagnetic tool to differentiate lacustrine-deltaic and fluvial-deltaic sedimentary environments is easily inferred. Besides, in the synoptic model (Fig. 19-B), the influence of cutting-off a branch meander (of the Sf. Gheorghe distributary; Fig. 17 and Fig. 19 –
Fig. 18 Pie-diagrams showing the percentage distribution of the magnetic susceptibility values (k) for bottom sediments of the Sf. Gheorghe Branch, related to 3 cases: a) samples collected from stations located along the entire Danube distributary (geoecological monitoring [1992-1998], 2003 and 2004 cruises); b) samples collected from two meanders (A and B, in Fig. 17), in 2003 and 2004; c) samples collected from stations located along the entire Danube distributary (1992-2004, data for meanders included).

Fig. 19 A synoptic model showing the magnetic susceptibility (MS) characterisation of the bottom sediments of the Danube Delta distributaries and an ecohydrological application of the enviromagnetic tool related to the Sf. Gheorghe Branch meanders case.
middle-up and middle-down) on the MS signatures is shown (B, down-right corner). The magnetic susceptibility values were obtained on a sediment collection sampled in the 2007 cruise; these results must be added to the previously presented data pertaining to the 2003 and 2004 cruises as proofs of the abilities of the enviromagnetic tool for ecohydrological applications.

In conclusion, by silting up processes, which mainly occur at the upstream and downstream meander ends, these zones are going to become “oxbow”-type lakes. The decreasing trend of the sediment grain size, upstream downstream, which is consistent with the transport force decrease, could result in decreasing of the magnetic susceptibility percentages assigned to the higher k classes (V₄ – Vₒ), which characterise the coarser sediments (i.e. sands), and in increasing of the percentages of the k classes III and IV, to which the finer sediments (e.g. mineral muds, clayey muds, coarse silicic muds) are calibrated. Discussing in an ecohydrological context, it can be mentioned that as opposed to the cruise from the autumn 2003, when the low waters were also associated with a lower speed of the Danube watercourse, during the spring 2004 cruise there were high waters, the water flow speed was higher, and generally, the deposited superficial sediments were coarser. The decreasing trend of the grain size of the sediments upstream downstream remains very pronounced, and the evolution of the modified distributary towards an “oxbow”-type lake is imminent.

In addition to these data, in the synoptic model from Fig. 19, the influence of the Danube River discharge in the Northwestern Black Sea is shown by the maximum k anomalies (marked by two blue rectangles; Fig. 19-A). As regards the Black Sea Littoral Zone, particularly concerning the lakes located in that area, some integrated enviromagnetic and lithological data pertaining to the most representative of them were presented in the Chapter 3.1.3.

4. CONCLUSIONS

The magnetic susceptibility (MS) results which were presented – independently or integrated with lithological data – with regard to the bottom sediments sampled from some representative lakes and a delta meandering distributary, located in three important southeastern Romania wetlands (i.e. Danube Delta, Razelm – Sinoe Lagoonal Complex and the Black Sea Littoral Zone), demonstrate the capability of the petromagnetic parameter (k; MS) to decipher sedimentogenetic, environmental and geocological contexts. Moreover, the composite models, shortly commented in the paper, argue that the magnetic susceptibility is a sensitive proxy parameter for characterising the lithology of the sedimentary environments from deltaic, lagoonal and littoral wetlands. For example, related to the deltaic lakes, the models emphasise the specific enviromagnetic fingerprints that characterise the allochthonous and autochthonous sedimentation, respectively. As regards the lagoonal and the littoral lakes, the coincidence between the sedimentary areas characterised by higher MS values and those defined as dominantly siliciclastic or by low MS intensity fingerprints and those rich in organic matter, respectively, is well reflected by corresponding anomalies of maximum and minimum values of the various parameters pertaining to the specific (k, SIL, TOM) maps; the previous results are confirmed (e.g. Rădan & Rădan, 2007; Rădan & Rădan, 2007d, in Rădan, 2008; Rădan et al., 2008).

By measuring the magnetic susceptibility in laboratory, well-defined MS fingerprints can be recovered from the recent sediments. They are associated with different lithological characteristics, making possible some connections with the distinct positions of the lakes related to the fluvial supplies, the hydrodynamic context or specific source-areas. Therewith, the (k) magnetic signatures detected within the lake sediments sampled at different time intervals – during more than 3 decades – can be reliable proofs for the evaluation of the changes that were produced within the aquatic ecosystems as a result of the impact of the human activities in the area.

Besides, the two particularity cases regarding the effects of the human intervention on the deltaic and fluvial-deltaic ecosystems (Danube Delta), which were analysed in the paper, show that the modifications of the hydrological regime induce changes of the sedimentary environments, and consequently, modifications of the magnetic susceptibility signatures. Therefore, the case of digging a new canal (i.e. Cn. “Mila 36”) between the Tulcea and Chilia Branches, in the western zone of the Mesteru – Fortuna Depression, and the case of cutting-off the meanders of the Sf. Gheorghe Danube distributary prove the capability for ecohydrological applications of the enviromagnetic tool, which is based on magnetic susceptibility measurements on bottom sediments. As concerns the first case, the Lungu and Meșteru Lakes are the most affected, the high sedimentation rate leading to a rapid filling-up with sediments, particularly in their northern and western sector, respectively. With regard to the latter case, some hydrobiological consequences were shown by comparing the fauna identified in the upstream sectors of the cut-off meanders of the Sf. Gheorghe Danube distributary with the fauna detected in the downstream zones, which get lacustrine trends (they are going to become “oxbow”-type lakes).

The data presented in the paper for the modern sediments sampled from deltaic, lagoonal and littoral lakes, some of them representing parts of “case-studies” or “history cases”, contribute to the development of the enviromagnetic archives recovered from ones of the most important wetlands of Romania.
REFERENCES


RĂDAN, S.C., RĂDAN, S., 2009 – Integrated magnetic susceptibility and lithological studies on lacustrine recent sediments from the Danube Delta. GEO-ECO-MARINA, 15, Bucharest, 177-197.


RĂDAN, S.C., RĂDAN, S., 2010a – Lake sediments fingerprinting in the Danube Delta, using composite magneto-lithological signatures; environmental and hydrosedimentary inferences, GEO-ECO-MARINA, 16, București-Constanța (this volume).


