

FE, MN AND ZN IN THE BOTTOM SEDIMENTS OF THE WIGRY LAKE – SZYJA BASIN

D. Prosovicz

AGH University of Science and Technology
Faculty of Geology, Geophysics and Environmental Protection
al. Mickiewicza 30, 30-059 Kraków, Poland

Phone: +48 12 617 2571, Fax: +48 12 633 29 36, e-mail: dproso@poczta.onet.pl

Abstract

Concentrations of iron, manganese and zinc were surveyed in bottom sediments of the Wigry lake, which is located in low industrialized area (north-eastern Poland) in the Wigierski National Park. The samples were taken from the deepest, trough part of the lake – Szyja Basin. Concentrations of Fe, Mn and Zn were determined with atomic absorption spectrometry (AAS). The elements were analyzed in the main types of bottom sediments: lacustrine chalk, calcareous gyttja and in different environments of sedimentation. Heavy metal contents were determined in the bottom sediments of the cross-profile of the basin. Iron, manganese and zinc were correlated with the depth of the lake and with the calcium carbonate concentrations. Correlations between elements were presented. Obtain results of studies in the bottom sediments showed that concentrations of metals varied in the wide ranges [mg/kg]: Fe from 263 to 9675, Mn from 32 to 3674 and Zn from 3 to 93.

Introduction

The Szyja Basin is the deepest, furrow-like part of the Wigry Lake, NE Poland, and is characterized by quiet sedimentation, except for the central part of the basin where a landslide-like structure occurs. The basin fill is dominated by carbonate deposition. Calcareous gyttjas are recently being deposited in the profundal zone, whereas the littoral zone is dominated by calcareous chalk, calcareous gyttjas, and sands. Calcium carbonate is recently being precipitated upon plants and due to biochemical processes. Vertical zonality of the sediments, particularly well visible in the profundal, as well as upward-decreasing CaCO₃ content and progressively darker colour of sediments point to deteriorating oxygenation conditions and increasing trophy of the lake (Rutkowski et al. 2003).

Geochemic description of the bottom sediments of the Wigry Lake has been given by Stangenberg (1938). The previous research of Fe, Mn, Zn were carried out in Bryzgiel Basin (Prosovicz&Rybicka 2002).

The following investigation referred to Fe, Mn, Zn distribution in the main types of bottom sediments of the Wigry Lake. Concentrations of metals and calcium carbonate were correlated with the lake's depth.

Methods

The samples of bottom sediments of the Wigry lake were taken by Rutkowski and Król in summer 1999-2002. Details concerning measurement procedures and principles of interpretations are given by Rutkowski et al. (2002). Geochemical survey was done for 37 bulk samples from the surface layer 0-5 cm of the deepest part of lake (Szyja Basin) (fig. 1). Sampling sites have been positioned with the help of GPS. Most of the coring sites have been localized upon seismoacoustic cross-sections. The depth from which samples

have been collected have been measured by an echosonde FCV. The localization of the analyzed cross profile is shown in fig. 2.

Extraction of metals: Zn, Fe, Mn, Ca in sediment samples was carried out in the mixture of 65% HNO₃ and 30% H₂O₂ in microwave oven. Concentrations of Ca, Fe, Mn, Zn were determined with atomic absorption spectrometry (ASA) upon material dried up to 105°C. The Ca content has been recalculated to CaCO₃.

Figure 1 Localization of research area

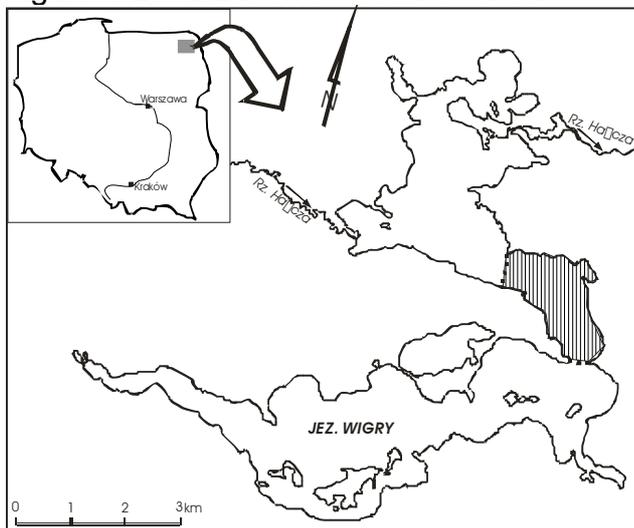
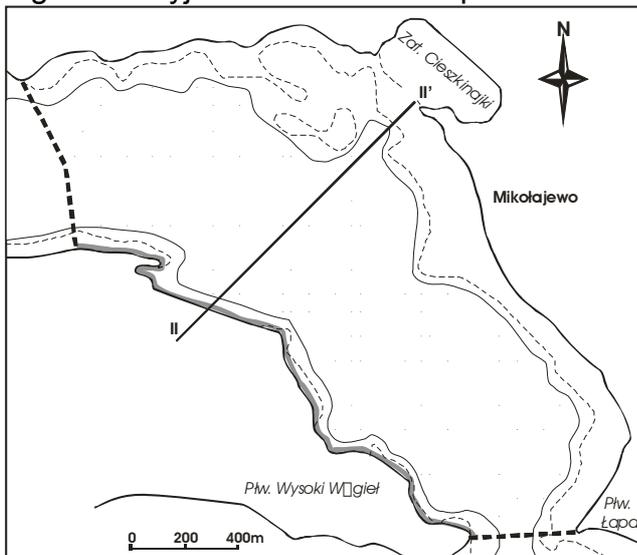


Figure 2 Szyja Basin with cross profile



Results and Discussion

The concentrations of analyzed metals in samples of bottom lake sediments varied from (mg/kg): 263 to 9675 of Fe 38.4-3674 of Mn, 4.3-93.4 of Zn and (weight%) 15.8 to 96.2 of CaCO₃ Table 1 shows the statistical parameters referring to concentrations of metals in all samples of the bottom sediments. Correlation coefficients for elements were shown in table 2. Figure 3 presents relationship between metals and the depth of the lake. The mean concentrations of Fe, Mn and Zn in littoral and profundal zone and lacustrine chalk, calcareous gyttja are shown in figure 4.

Concentration of CaCO₃ in bottom sediments of the Wigry Lake was variable with the average value 58.8 %. No correlation has been observed between CaCO₃ and Fe, Mn, Zn concentration and depth of the lake (Fig. 3).

Average concentration of iron was relatively low (3108 mg/kg) and its increase with the depth of the lake was observed (Tab. 2). Average values of Fe content (mg/kg) were: in littoral zone – 1151, in profundal zone – 4623, in lacustrine chalk – 731 and in calcareous gyttja – 3304.

Concentration of Mn strongly depends on lake depth (Tab. 2). Average concentration of this metal in the samples taken from shallows was (mg/kg) 80.6, from deepest parts 831, in lacustrine chalk 90.7 and calcareous gyttja 529.

Average concentration of Zn in the studied samples was 32 mg/kg. In the shallow areas the amount of this metal was on the average four times as lower as in the deeper areas (12.4 and 48.4 mg/kg). Analogical results of concentrations of Zn in samples of lacustrine chalk were on the average three times as lower as in these of calcareous gyttja (10.4 and 34.3 mg/kg).

The results of Zn concentrations obtained from the bottom sediments samples from the Szyja Basin are similar to the average concentration of Zn in other bottom sediments of surface waters of Poland (73 ppm) (Lis&Pasiczna, 1995). Considering that the geochemical background of Zn determined by Turekian and Wedepohl (1961) for carbonate rocks amounts 25 ppm, only sediments of calcareous gyttja and sediments from deeper areas are slightly polluted.

Figure 5 presents the concentrations of Fe, Mn and Zn in samples taken from the cross profile of the Szyja Basin. There is a strong correlation between the amount of metals and depth of the lake. The highest concentrations of analyzed elements were observed in the deepest part of the basin and appeared lower in the shallow areas.

Table 1: Statistical parameters of concentration Fe, Mn, Zn [mg/kg] of bottom sediments in the Wigry Lake

	Fe	Mn	Zn
Minimum	263	38.4	4.3
Maximum	9675	3674	93.4
Arithmetic mean	3108	453	32

Table 2: Correlation coefficients for chemical parameters and lake Wigry depth

	CaCO₃	Fe	Mn	Zn	Lake depth
CaCO₃	x	-0.02	-0.06	0.06	-0.03
Fe		x	0.68	0.87	0.85
Mn			x	0.58	0.76
Zn				x	0.86
Lake depth					x

Figure 3 Changes of calcium carbonate with bottom sediments depth

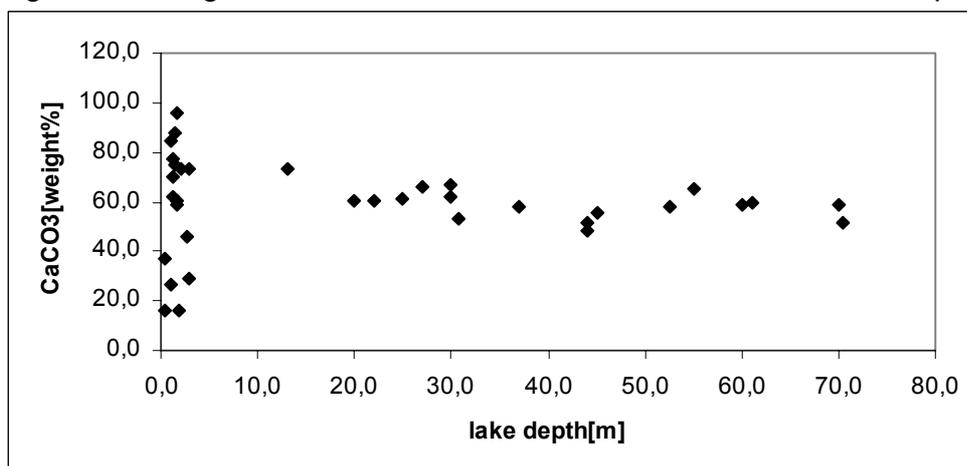


Figure 4 Concentrations of Fe, Mn, Zn in the main types of sediments and environments of sedimentation of the Wigry Lake

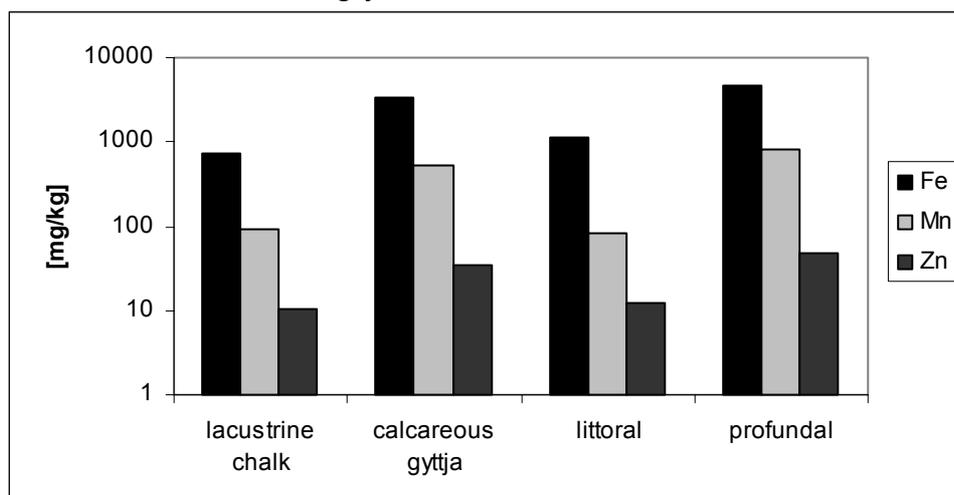
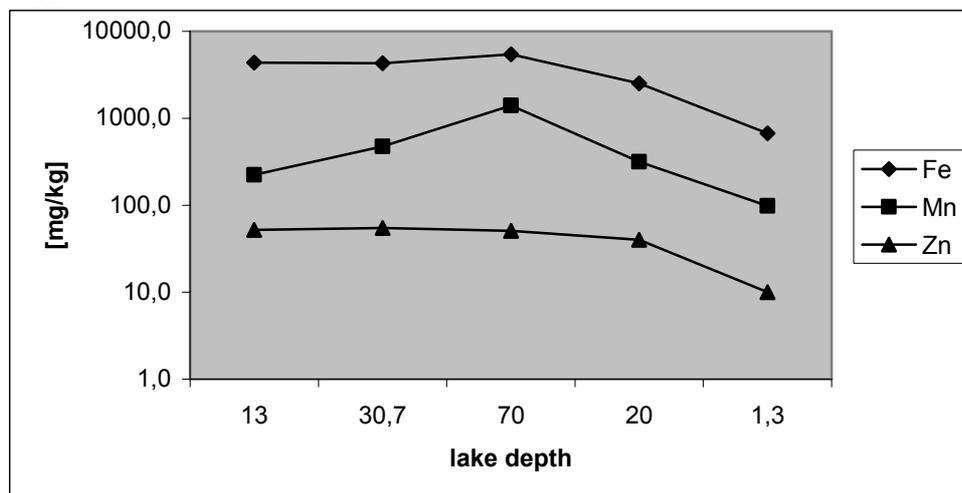


Figure 5 Concentrations of Fe, Mn, Zn in the bottom sediments in the cross profile of the Szyja Basin



Conclusions

Concentrations of Fe, Mn, Zn in the bottom sediments of the Wigry Lake (Szyja Basin) depend on the type of sediment and environment of sedimentation

Amount of Fe, Mn, Zn is on the average three times as higher in samples of calcareous gytja as in these of lacustrine chalk

Similarly the concentrations of analyzed metals in the samples from profundal zone are on the average four times as higher as in littoral zone.

Obtained results show a high correlation of Fe with Zn

The highest amount of Fe, Mn and Zn found in the samples from isolated and cultivated Cieszkinajki Bay points to pollution of that part of the lake. However it still needs further research.

Acknowledgments

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References

- (1) J. Lis, A. Pasieczna, Atlas geochemiczny Polski, Państwowy Instytut Geologiczny, Warszawa, (1995)
- (2) D. Prosoicz, E. Helios-Rybicka, Trace metals in recent bottom sediments of Lake Wigry (Bryzgiel Basin), vol 2, 323-332, (2002)
- (3) J. Rutkowski, K. Król, L. Krzysztofiak, D. Prosoicz, Recent sediments of the Wigry Lake (Szyja Basin), NE Poland, Limnological Review, vol. 3 (2003)
- (4) J. Rutkowski, K. Król, L. Krzysztofiak, D. Prosoicz, Recent sediments of the Wigry Lake (Bryzgiel Basin), Limnological Review, vol 2, 353-362 (2002)
- (5) M. Stangenberg, Skład chemiczny osadów głębinowych jezior Suwalszczyzny, Rozprawy Instytutu Badawczego Lasów Państwowych, seria A, Nr 31, 5-40, Warszawa, (1938)
- (6) K.K. Turekian, K.H. Wedepohl, Distribution of the elements in some major units of the earth's crust, Bull. Geol. Soc. Am., 72, 175-192, (1961)