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Modern Lacustrine Sediments of Ukrainian Polissia and Their Classification

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SUMMARY

Lakes and sapropelic sediments are widely distributed throughout Ukrainian Polissia. Their study and comprehensive utilization should be regarded as a task of considerable scientific and practical importance. The need to classify lake bottom sediments is driven by the necessity of their practical application in various sectors of the economy. Bottom sediments of modern lakes in Ukrainian Polissia are represented primarily by sapropels. Sapropels have not been widely utilized due to insufficient knowledge of their properties and resources, particularly their key geochemical characteristics, which determine their quality and potential applications. A scientifically grounded classification of bottom sediments (sapropels) will contribute to a better understanding of the challenges associated with their rational utilization. Industrial use of sapropel resources requires not only a quantitative assessment of available reserves but also a comprehensive evaluation of their quality indicators and physical properties to enable the differentiated selection of raw-material sources for specific applications and appropriate extraction methods. The vast majority of sapropel types found in the region are suitable for use in various sectors of the economy.

Keywords: Lakes; Bottom sediments; Sapropel; Classification; Typology; Utilization; Ukrainian Polissia.

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Introduction

The ability of lakes to accumulate material makes them an invaluable repository of information on long-term changes in sediment accumulation, as well as on global and regional factors that determine the development of water bodies and the conditions under which mineral and organic components enter and accumulate in them. This allows for the reconstruction of global changes in hydrological conditions and the influence of climatic cyclicity on the evolution of terrestrial and aquatic vegetation, and contributes to a better understanding of millennial, centennial, and sub-centennial climatic cycles during the Holocene.

The available data on the chemical composition of different types of lakes in Ukrainian Polissia allow for reliable typological classification and characterization of modern sedimentation processes. Such studies are necessary for regionalizing the territory according to sedimentation types. The synthesis of data on sediment formation in the lakes of Ukrainian Polissia provides a geochemical information base on the types of lacustrine sediments, the conditions of their formation, and the geochemistry of individual elements as indicators of sedimentogenesis and early diagenesis processes and environments. The sedimentary sequences of modern lake deposits are regarded as a typical geochemical environment of freshwater sediment accumulation in the mixed-forest zone.

Methods

The classification of lacustrine sediments should be regarded as a systematic organization of knowledge about modern organogenic sediments - sapropels. Classification is necessary not only as a scientific systematization of knowledge about lacustrine sediments but also for their assessment and for determining appropriate options for their economic utilization.

The classification of sapropels is based on: (a) the genetic principle, i.e., the identification of sapropel groups according to their formation processes; (b) the properties of the sapropelic sediments themselves; (c) their physical and chemical properties; and (d) their external and internal microstructural characteristics. For the study region, we developed a classification of lacustrine sediments that makes it possible to identify the most promising applications of sapropel based on its composition and properties. In our view, this classification helps prevent the inefficient use of the most valuable classes in areas where they can be replaced by less valuable raw materials. A limitation of this classification is that it does not take into account the biological characteristics of sapropelic sediments or the origin and composition of the organic matter. The genetic aspect is reflected in the ratio of organic and mineral components in the lacustrine sediments we studied. This classification most fully reflects the quality characteristics of sapropels and the most rational ways of utilizing them and, to a considerable extent, can also be applied to the classification (typology) of sapropels from other similar regions of Europe and North America.

The classification of natural water bodies (lakes) according to various parameters has a long history and established traditions. Such classifications facilitate the understanding and assessment of water and mineral resources, the prediction of their condition as well as the monitoring, management, and protection of lakes. The analysis of lake bottom sediments is based on the theoretical and methodological principles of modern limnology (Balasubramanian, 2015; Cole et al., 2016; Argillier et al., 2022), the geochemistry of lacustrine sediments (Bertrand et al., 2024; Ilyina et al., 2025), and analytical methods for the chemical investigation of lakes and the interpretation of their results (Anastasakis et al., 1984; Alexandre, 2021; Frančišković-Bilinski et al., 2021). The study of lake bottom sediments is an important research area and is considered an essential component in the assessment of pollution in natural and artificial water bodies (Hoffman, 1988; Ran et al., 2023).
To date, there is no unified approach to the terminology and classification of bottom sediments. It is generally accepted that the main characteristic distinguishing the sediments of lakes in humid zones is the composition and quantity of organic matter. In our view, the accumulation of organic matter is the

most important typological characteristic of lakes in humid zones and should form the basis for the classification of lacustrine sediments.

The present study is based on our previous comprehensive geochemical analyses of the composition of lacustrine sediments in the region (Ilyina et al., 2025; Ilyin et al., 2026), as well as archival data from the State Scientific and Production Enterprise "Geoinform of Ukraine." In developing the classification, data on the bottom sediments of 234 lakes in Ukrainian Polissia were analyzed and taken into account.

Results

Sapropelic sediments are divided into three types: biogenic, clastogenic, and altered. The types are subdivided into classes based on the proportions of organic and mineral components and their genesis. Six classes are distinguished: organic, siliceous, organo-silicate, silicate, carbonate, and ferruginous. The name of each type reflects the composition of its organic and mineral components, their proportions, and their origin. A total of 14 sapropel types have been identified in Ukrainian Polissia.
The largest amount of sapropel is concentrated in Volyn Oblast (52998 thousand tonnes), with considerably smaller amounts in Rivne Oblast (8381.1 thousand tonnes), Kyiv Oblast (1290.7 thousand tonnes), Sumy Oblast (1180.1 thousand tonnes), and Chernihiv Oblast (33.0 thousand tonnes). The total balance reserves of sapropel amount to 63882.8 thousand tonnes. In the study area, the dominant types of sapropel are organo-calcareous (17031.4 thousand tonnes), calcareous (12712.7 thousand tonnes), organo-ferruginous (9761.5 thousand tonnes), organo-clayey (7934.6 thousand tonnes), and organo-sandy (5619.2 thousand tonnes) (Table 1). These types are most suitable for use in agriculture as fertilizers, for neutralizing acidic soils, which are widespread in the study region, as animal feed supplements, and in balneological practices as therapeutic mud.

Table 1. *Distribution of lake bottom sediments (sapropels) in Ukrainian Polissia by type (thousand tonnes)*

Sapropel type	***Administrative region***				
	Volyn	***Rivne***	***Kyiv***	***Sumy***	***Chernihiv***
mixed-algal	1741.1	280.2	11.4	–	–
peaty	756.2	226.3	–	–	–
zoogenous-algal	5148.0	166.1	–	–	–
diatomaceous	1030.8	142.1	–	–	–
organo-sandy	3766.9	1732,4	119.9	–	–
organo-clayy	5097.9	1940,7	709,1	187.1	–
organo-calcareous	15344.0	262.0	450.4	975.0	–
calcareous	12070.4	609.3	–	–	33.0
organo-ferruginous	7811.7	1949.8	–	–	–
calcareous-ferruginous	231,1	–	–	–	–
diatomaceous-clayyy	–	61.5	–	–	–
clayy-calcareous	–	1010.9	–	–	–
cyanophycean	–	–	–	18.0	–

Other types of sapropel are also present in Ukrainian Polissia, including zoogenic-algal (5314.0 thousand tonnes), mixed-algal (2032.7 thousand tonnes), clayey-calcareous (1010.9 thousand tonnes), diatomaceous (1172.8 thousand tonnes), peaty (982.5 thousand tonnes), diatomaceous-clayey (61.5 thousand tonnes), and cyanophycean (18 thousand tonnes) (Figure 1).

The most promising areas for the utilization of sapropels in the region include agriculture (production of fertilizers, liming materials, sapropel-manure and other composts, industrial production of organo-mineral fertilizers, production of substrates for growing beneficial bacteria, various packaged nutrient mixtures for horticulture, greenhouses, and conservatories, and plant growth stimulants); animal husbandry and veterinary medicine (production of mineral and vitamin feed additives based on

organic and carbonate sapropels); land reclamation and the building materials industry, where sapropels can be used as technological additives (production of permeable drainage pipes, expanded clay, facing bricks, lightweight wall blocks, etc.); medicine (therapeutic muds and medicinal preparations); geology (drilling fluids); and other applications (Table 2).

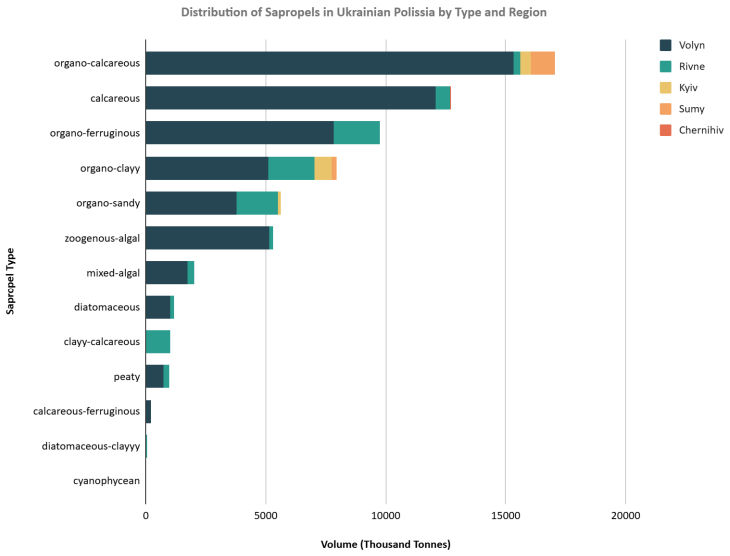

Figure 1. *Distribution of sapropels in Ukrainian Polissia by type, thousand tonnes*

Table 2. *Promising applications of different types of lake bottom sediments (sapropels) in Ukrainian Polissia*

Sapropelic sediments	Type	Class and representative varieties	Potential economic applications
Lake bottom sediments sapropels	**Biogenic**	**Organic** → proto□o□□al; cyanophycean; mixed-algal; peaty; zoogenic-algal	organic fertilizers; feed additives (except for the peaty variety); therapeutic muds; building materials; drilling fluids
		Siliceous → diatomaceous	organic fertilizers
	Clastogenic	**Organosilicate** → organo-sandy; diatomaceous-sandy; organo-clayey; diatomaceous-clayey	organic fertilizers; therapeutic muds
		Silicate → sandy; □layey	soil ameliorants for soil improvement
	Mixed	**Carbonate** → organo-calcareous; clayey-calcareous; calcareous	organic fertilizers; soil ameliorants for neutralizing acidic soils
		Ferruginous → organo-ferruginous; calcareous-ferruginous	organic fertilizers
		Sulphide Limonite	not suitable for use

Conclusions

The synthesis of extensive empirical data on diverse bottom sediments formed under different natural conditions in Ukrainian Polissia is essential for understanding the patterns governing their formation. This is important for advancing the study of these sediments and their targeted scientific analysis to a new theoretical level. The available data on the composition of sediments from different types of lakes in Ukrainian Polissia allow for reliable typological classification and characterization of modern sedimentation processes.

The accumulation of organic matter, which is characteristic of the current stage of lake development in Ukrainian Polissia, is the main factor determining the progressive changes in the geochemical environment of lake basins. Among the types of lacustrine sedimentation identified in the region, organic accumulation plays the dominant role. Most lakes in the region are producers of organic matter. This reflects, above all, the general trend in sediment accumulation characteristic of lakes in humid zones.

The natural diversity of sapropels in Ukrainian Polissia determines their potential for a wide range of applications. The rational utilization of sapropels can be facilitated by a classification that reflects their most important characteristics and identifies appropriate areas of application within the established taxonomic units. Most sapropel types occurring in the region are suitable for use in various sectors of the economy. Establishing a clear classification scheme for lacustrine sediments is necessary not only for the scientific systematization of knowledge but also for the subsequent assessment of sapropel deposits.

Future research on sapropels in the region should focus on assessing the balneological potential of promising deposits and developing regional programs for the development and utilization of sapropelic peloids.

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