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PALEO GEOGRAPHIC RESEARCHES IN THE INSTITUTE OF GEOGRAPHY OF THE NATIONAL ACADEMY OF SCIENCES OF UKRAINE AND MODERN APPLIED DIRECTIONS OF THEIR USE
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Abstract. Study of the history of nature in the past are in the main directions of modern world scientific trends. In the sector of paleogeography of the Institute of Geography of the National Academy of Sciences of Ukraine traditionally develop fundamental and applied aspects related to the study of late Cenozoic sediments. The subject of the works is related to the research of the history and stages of development of nature and its components on the territory of Ukraine in the Pliocene, Pleistocene and Holocene, as well as the reproduction of natural living conditions of ancient man.

The publication focuses on the main directions and scientific results, achieved by the scientists of the Sector Paleogeography of the Institute of Geography of the National Academy of Sciences of Ukraine in recent years. In particular, the issue of the impact of global Pleistocene events on the state and evolution of the main components of nature of the territory of Ukraine has been studied; paleogeographic preconditions that contributed to the formation of certain types of sedimentary Cenozoic minerals in Ukraine are outlined; the main natural factors of the paleogeographic environment that influenced changes in human living conditions in Ukraine in the Pleistocene and Holocene are considered; changes in Pleistocene and Holocene soils in key areas of modern Ukraine have been reconstructed.

Promising areas of investigation have been identified and an assessment of the possible applied use of the results of paleogeographic research has been made. Thus, the results of paleogeographic research, as well as professional services of paleogeographers can be used: to assess current climate change based on paleogeographic data; for geological additional research and rational use of the subsoil of Ukraine; to develop popular scientific and educational information on the paleogeographical features of the development of nature reserves and geological sites with tourist and recreational potential; to assess the current state and dynamics of spatio-temporal changes in environmental conditions based on paleogeographic analysis of the content of various substances in soils; during geoarchaeological, paleontological, soil research, etc.

Key words: paleogeographical research; climate changes; minerals formation; stratigraphy; human living conditions.

**ПАЛЕОГЕОГРАФІЧНІ ДОСЛІДЖЕННЯ В ІНСТИТУТІ ГЕОГРАФІЇ
НАЦІОНАЛЬНОЇ АКАДЕМІЇ НАУК УКРАЇНИ ТА СУЧАСНІ ПРИКЛАДНІ
НАПРЯМИ ЇХНЬОГО ВИКОРИСТАННЯ**

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Анотація. Дослідження історії розвитку природи у минулому перебувають у тренді сучасних світових наукових напрямів. У секторі палеогеографії Інституту географії Національної академії наук України традиційно займаються розробкою фундаментальних і прикладних аспектів, присвячених вивченню відкладів пізнього кайнозою. Тематика робіт пов'язана з дослідженням історії та етапності розвитку природи і її компонентів на території України у пліоцені, плейстоцені та голоцені, а також відтворенням природних умов життя давньої людини.

У публікації акцентовано увагу на основних напрямках та напрацюваннях співробітників сектору палеогеографії Інституту географії НАН України за останні роки. Зокрема, опрацьовано питання впливу глобальних подій плейстоцену на стан та еволюцію основних компонентів природи України; окреслено палеогеографічні передумови, які сприяли утворенню окремих видів осадових кайнозойських корисних копалин на території України; виокремлено головні природні чинники палеогеографічного середовища, які впливали на зміни умов проживання людини на території України у плейстоцені та голоцені; реконструйовано зміни плейстоценових і голоценових ґрунтів на ключових ділянках сучасної території України.

Виокремлено перспективні напрями досліджень та зроблено оцінку можливого прикладного використання отриманих результатів палеогеографічних досліджень. Так, результати палеогеографічних досліджень, а також фахові послуги співробітників сектору палеогеографії можуть бути використані: для оцінки сучасних змін клімату на основі палеогеографічних даних; для геологічного довивчення та раціонального використання надр України; для розробки популярної науково-освітньої інформації щодо палеогеографічних особливостей розвитку природно-заповідних територій та геологічних об'єктів з туристично-рекреаційним потенціалом; для оцінки сучасного стану та динаміки просторово-часових змін екологічних обстановок на основі палеогеографічного аналізу вмісту різних речовин у ґрунтах; застосовані під час георхеологічних, палеонтологічних, ґрунтознавчих досліджень тощо.

Ключові слова: палеогеографічні дослідження; зміни клімату; утворення корисних копалин; стратиграфія; умови життя людини.

The relevance of paleogeography research is due to the need to solve fundamental scientific problems in the history of the nature past development are in the trend of modern world scientific investigation with study of the Quaternary period.

The aim of the work is to highlight the main scientific directions in received by employees of the paleogeography sector of the Institute of Geography of the NAS of Ukraine in recent years, to identify promising areas for further research and assess the prospects for their practical implementation.

Among the obtained results the fundamental research from the history of the development of the Earth's nature in the Late Cenozoic at is being continued by the staff of the paleogeography sector. The history of the paleogeography sector (department) begins with the creation in 1961 of the department of Physical Geography and Cartography at the Institute of Geological Sciences of the USSR Academy of Sciences, on the basis of which in 1964 the Sector of Geography was transformed and subsequently transformed (in 1991) into the Institute of Geography of the NAS of Ukraine.

The founder of the Sector (Department) of paleogeography and the its first head was the Doctor of geology and mineralogical sciences M.F. Veklych, who led it for 30 years (1961–1990). Later the Sector was headed by doctor of geographical sciences S.I. Turlo (1991–1994), and since 1994 – headed by doctor of geographical sciences, full professor Zh.M. Matviishyna.

Basic knowledge about ancient nature scientists of sector of paleogeography carries out in several directions: in the development of theoretical, methodical and methodological, general scientific bases of paleogeography; in the general, sectoral and regional paleogeographic studies of Late Cenozoic; in the development of a complex approach to the study of ancient nature, collaboration and substantiating of climatostratigraphic shemes. In the recent years, the subjects of the investigation of paleogeography sector scientists have been connected with the study of the history and small stage of development of nature and its components in the Pliocene, Pleistocene and Holocene, as well as the reconstruction of environmental conditions of life style of ancient peoples in the separate stages of Pleistocene and Holocene, as well as the restoration of natural conditions of life of an ancient person.

Perspective scientific results for the scientists of Sector are available:

- climate change trends, the evolution of paleolandscapes and their components in the Pleistocene and Holocene, their differences in time and space;
- evolution and small rhythms of Holocene soils and landscapes formation, bounding up with climate changes;
- paleoecogeography and conditions human activity at individual stages of the Pleistocene and small chrono-intervals of the Holocene;
- paleogeographic reconstructions of conditions of the Cenozoic sedimentary minerals formation for the expansion of mineral resources base of Ukraine;
- perfecting of the Pleistocene and Holocene stratigraphic schemes, correlation of Quaternary deposits of Ukraine with adjacent territories, coordination of paleogeographic schemes with archeological ones;
- implementation of paleoecogeographic data to the resolution of environmental pollution issues;
- prognosis of climate and nature changes in Ukraine on future.

The medium-term main directions of the paleogeography sector research are:

- study of ancient and modern soils in relation to climate change, reproduction of fractional stages and dynamic of their development in time and space, use of soil data for the reconstruction of paleolandscapes in separate stages of the Pleistocene and Holocene (Fig. 1).

– reproduction of the ancient ecological conditions for human habitation on the territory of Ukraine in separate stages of Pleistocene and Holocene based on paleogeographical data of the individual key studies; correlation of paleogeographical, archeological and historical data, including for reproduction of cultural dynamics and processes of development of new lands in the modern territory of Ukraine during in the Paleolithic, Neolithic, Copper, Bronze, Iron age etc. (Fig. 2).

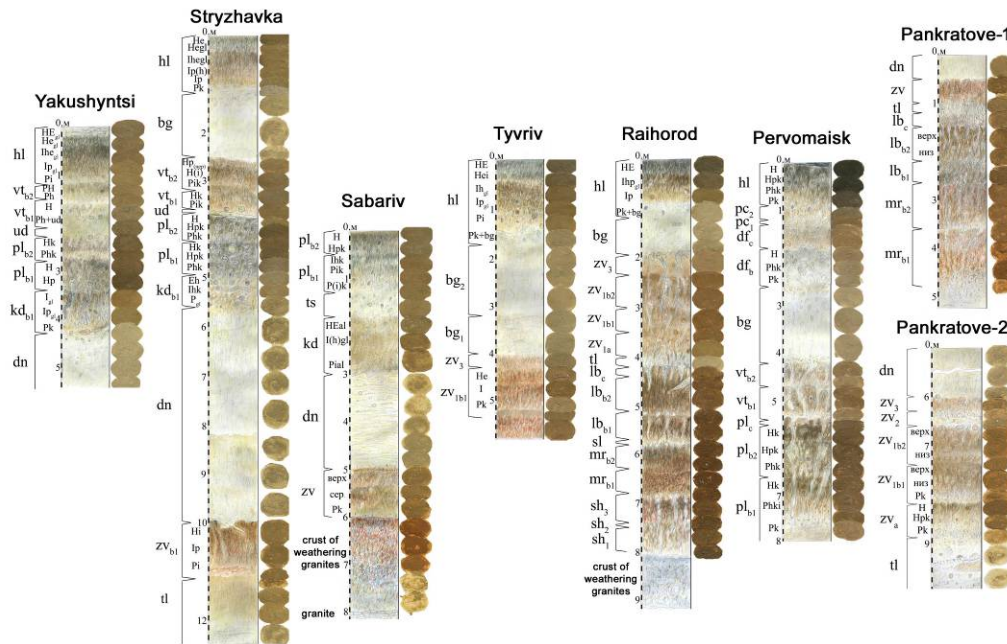


Figure 1. The field sketches of the sections with samples of natural material Pleistocene deposits of the Middle Pobuzhzhya (after Zh. Matviishyna and S. Doroshkevych). (On the top – name of the section. From left to right: indexes of the stratigraphical horizons; genetic horizons; deep in m; lithological column; samples of the natural materials)

– study of perspective methods and directions of paleogeographic assessment of natural conditions for formation and accumulation of certain types of exogenous origin minerals during some stages of Phanerozoic in the territory of Ukraine (Fig. 3).

In recent years (2008–2020), Sector employees have been working the problem of the impact of global events, that occurred in the Pleistocene, on the state and evolution of the basic components of nature in Ukraine (2008–2011, № State registration in UkrISTEI 0109U001046), have been distinguished the major natural factors of the paleogeographical environment that influenced changes in the habitat of people on the territory of Ukraine in the Pleistocene and Holocene (2012–2016, № State registration in UkrISTEI 0112U001135), have been outlined paleogeographical conditions that contributed to the formation of certain Cenozoic mineral deposits in Ukraine (2008–2016, № State registration in UkrISTEI 0112U001632) and changes of Pleistocene and Holocene soils in key areas of the modern territory of Ukraine as a basis for reconstructions of natural conditions of the past are characterized (2017–2020, № State registration in UkrISTEI 0117U004907).

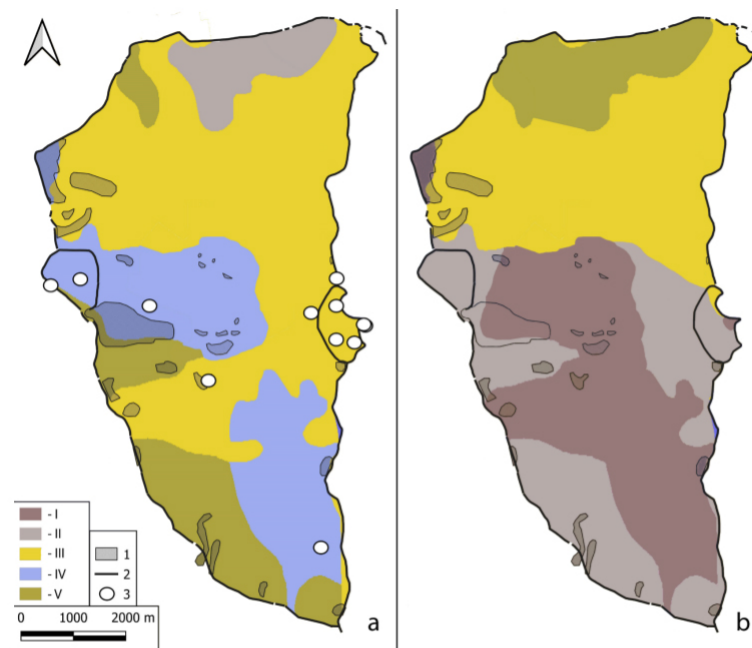


Figure 2. The map of the soils of Bilsk hillfort :
a – modern soils; *b* – soils of the Scythian time; I – common chernozems;
 II – leached chernozems; III – dark-grey podsolised soils; IV – typical chernozems;
 V – podsolised chernozems. 1 – the settlements on the territory of the complex;
 2 – rampart; 3 – sites of palaeopedological studies



Figure 3. Section Korobchyne-quarry (photo taken from the north-western part, from the side of the beam with a stream flowing into the river Velyka Vys) :
 1 – sands with industrial content of ilmenite; 2 – thickness of flint; 3 – sands of the stage P₂kv; 4 – greenish-gray sands of P₃hr; 5 – whitish sands of the N₁; 6 – brown Miocene clays; 7 – Pliocene deposits; 8 – Pleistocene and Holocene deposits

Currently, the Sector is working on the development of the methodology of step-by-step reconstructions of natural conditions of the plain territory of Ukraine in the Quaternary period and its implementation in the GIS-technology (2021–2024, № State registration in UkrISTEI 0112U107465).

The obtained scientific results are based on the analysis of numerous literature sources, as well as data from field and laboratory studies of sediments within numerous archeological and nature sites. They are reflected in numerous monographs and articles authored and co-authored by paleogeographers (Fig. 4). Paleolandscape maps of some stages of the Pliocene and Pleistocene for the territory of Ukraine in the National Atlas of Ukraine (2007), Comprehensive Atlas of Ukraine (2005) and Atlas of Kyiv region (2009) are created (authors – Zhanna Matviyshyna and Natalia Gerasimenko). References to paleogeographic publications of recent years are also in the monograph edited by Academician Leonid Rudenko "Academic Geography and Satin Mapping during the years of independence of Ukraine" (Rudenko et al, 2021).



Figure 4. Monographs of recent years, authors and co-authors of which are employees of the paleogeography sector (Dmytruk, Matviishyna & Sliusarchuk, 2008; Karmazynenko, 2010; Matviishyna et al., 2010; Matviishyna & Doroshkevych, 2014; Matviishyna & Karmazynenko, 2014, 2015; Stepanchuk et al., 2013; Tykhonenko, Matviishyna & Horin, 2005; Zalizniak et al., 2013)

The study of changes in the natural conditions of the past in Ukraine is based on methods of studying fossil soils as an important component of natural environment and indicators of climate change. The methodological essence of these studies is to take into account the fact that the deposits of ancient geological epochs (including fossil soils) are direct monuments of ancient soils and a kind of indicators of physic-

geographical conditions of their formation. In the course of research the generalization of the existing approaches and experience of predecessors concerning changes of soils and factors of soil formation on the territory of Ukraine in the Pleistocene and Holocene is carried out.

The method of studying changes in the natural conditions of the past on the basis of new facts and analytical materials for the study of Pleistocene and Holocene soils and sediments has been improved (with the active use of micromorphological analysis, which allows genetic identification of different ages of soils and soil species to carry out (Fig. 5)).

The geoarchaeological approach was mainly used for paleogeographic reconstructions of the Holocene. Its essence is to study the buried (“preserved”) soil under the archaeological site (clearly dated) and compare the features of the buried soil with the modern background.

Separate step-by-step maps of different ages of soil cover and paleolandscapes have been built. The history of soil development in separate stages of the Pleistocene and Holocene in key areas of modern Ukraine (Middle and Lower Pobuzhye, Dnieper, Azov, Polissya, Left Bank Dnieper forest-steppe, etc.) is reproduced.

During 2017–2021 the sector paleogeography worked on the topics: “Changes in Pleistocene and Holocene soils in key areas of the present-day territory of Ukraine as a basis for reconstruction of natural conditions of the past” and “Paleogeographical factors and methods for exploring the formation and accumulation of mineral resources in the context of expanding the prospect of mineral reserves in Ukraine”. The most important results of the study of changes in the natural conditions of the Pleistocene and Holocene based on studies of soils and soil deposits have been published in monographs (Fig. 6), brochures, 16 articles in Scopus and Web of Science databases and 24 articles in other cited publications (works of Zh. Matviishyna, A. Ivchenko, S. Doroshkevych, S. Karmazynenko, O. Matsibora, A. Kushnir).

In today's, it is especially important to introduce scientific results, that's which is why the paleogeography sector employees see the main task in promoting the gainful for society knowledge in practice, as well as establishing cooperation with the executive authorities, ministries, departments, local communities. However, in Ukraine it depends very much on the willingness of the customers themselves to use the results of scientific research. Particular attention should be paid to the government, which should be interested in collaborating with relevant scientific organizations, which should assist it in the development of the state.

Among the governmental organizations that may be interested in the work of the paleogeography sector is the Ministry of Ecology and Natural Resources of Ukraine. According to the information published on the official site of the Ministry (<https://mepr.gov.ua/>), some results of paleogeographic studies as well as professional services of employees of the paleogeography sector of the Institute of Geography of NAS of Ukraine can be used by the Ministry in the following directions its activities:

– climate change and the ozone layer (services for the assessment of modern climate change based on paleogeographical data);

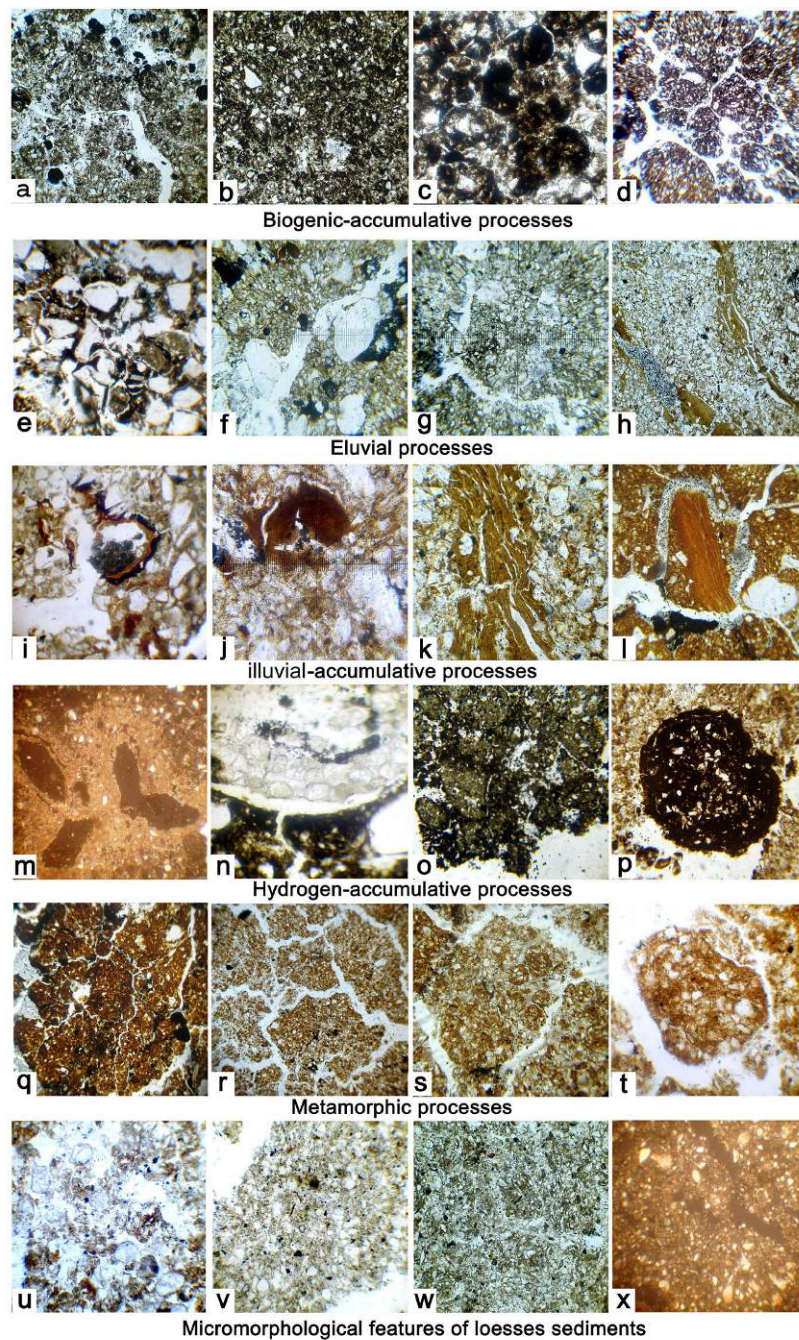


Figure 5. Certain typical micromorphological diagnostic features of the main groups of soil formation processes in the differ aged Pleistocene soils of the Middle Pobuzhya (Matviishyna & Doroshkevych, 2019) :

Biogenic–accumulative: a) complex microaggregation of chernozem of brownzem–liked (pl_{b2} ; Yakushyntsi) /magn. 100/; b) microstructure of the humus horizon of meadow chernozem (pl_{b1} ; Yakushyntsi) /magn. 100/; c) humus coagulated in the form of humons in the humus horizon of meadow chernozem (pl_{b1} ; Yakushyntsi) /magn. 400/; d) coprolites of rain worms

combined in the complex microaggregates, separated by a net of twisted pores, in the humus horizon of the meadow chernozem (p_{b1} ; Pervomaisk) /magn. 70/ (nic.||).

Eluvial: e) microstructure of the humus-eluvial horizon of sod-podzolic soils (kd_{b1} ; Bezimenne) /magn. 70/; f, g) “washed” grains of the mineral skeleton are cemented with amorphous plasma in the eluvial–humus horizon of gray podzolized soil (kd_{b1} ; Stryzhavka) /magn. 80/; h) new formations of polynite (calomorph clay) in the form of scaly streaks on the pore walls (kd_{b1} ; Yakushyntsi) /magn. 100/ (nic.||).

Illuvial–accumulative: i) manganese–ferruginous–clayey colomorph clay formation on the walls of pores of sod–gleyd soil (kd_a ; Bezimenne) /magn. 70/; j) scale influx of calomorph clays in the brown podzolized forest soil (kd_{b1} ; Stryzhavka) /magn. 400/; k) the influx of colomorph clays in the illuvial horizon of gray podzolized soil (kd_{b1} ; Yakushyntsi) /magn. 400/; l) ferruginous–clayey influx of colomorph clays in the pore of reddish–brown meadow soil (sh; Raihorod) /magn. 100/ (nic.||).

Hydrogen-accumulative: m) concentrations of microcrystalline around the pore in the lower part of the brown soil (vt_{b2} ; Medzhybizh) /magn. 70/; n) microconcentration of fine crystalline calcite in the pore of brown soil (vt_{b2} ; Vyss) /magn. 140/; o) films and flakes of hydroxides of iron and manganese in reddish-cinnamonish brown soils (mr_{b2} ; Raihorod) /magn. 100/; p) dense glandular-manganese concentric microorsteins in dark brown soil (vt_{b1} ; Yakushyntsi) /magn. 100/ (n–p – nic.||, m – nic. +).

Metamorphic: q) cinnamon–brown ferruginous-clay plasma, with a small fraction of the dusty grains of the skeleton, in the reddish–brown meadow soils (sh; Raihorod) /magn. 100/; r) cleave block microstructure of brown forest soils (zv_{1b1} ; Raihorod) /magn. 40/; s) the ferruginous-clay substance is segregated into nodular formations, which are tightly packed in cleave blocks in brown forest soils (zv_{1b1} ; Raihorod) /magn. 100/; t) the nodule of the ferruginous-clay substance from the middle part of the brown soil (vt_{b2} ; Ozerove) /magn. 140/ (nic.||).

Micromorphological features of loesses sediments: u) microstructure of the Prychemomorya loess, the proportion of loess particles with seeds of primary minerals, large calcite crystals (Pervomaisk) /magn. 140/; v) the seeds of primary minerals are commensurate with the loess particles, covered with carbonate-clay films (Bezimenne) /magn. 140/; w) friable microstructure of the Dnipro loess (Yakushyntsi) /magn. 100/; x) dust–plasmic microstructure of the Uday loess, mass is impregnated with microcrystalline calcite (Korobchyne) /magn. 70/ (u–w – nic.||, x – nic. +).



Палеогеографічний етап	Тривалість, тис. років	Земельні ґрунти та ґрунтові підстави	Земельні ландшафти	Клімат				Рельєф
				Середньорічна температура, °C	Найвищою щільною місяця	Найнижчою щільною місяця	Середньорічна кількість опадів, мм	
ГОЛОЦЕН (1 ОІС, сучасний етап розвитку природи)	0–10	Високо-сірі, сірі та темно-сірі опідзолені ґрунти, чорноземні опідзолені, вилужені, типові та змивні	Перевално лісостепові, на півдні – степові	+ 8	+19	-6	500–650	Сучасний вигляд земної поверхні
ПРИЧОРНОМОРСЬКИЙ (кінць 2 ОІС, останній стадія, атлантський, Калідов-алерей)	10–15	Лісоподобні суглинки та лесні	Перигляціальні степові та суглинисті	-8	+9...+10	-15...-10	250–300	Закриплення формуванням останнього вигляду сучасних форм земної поверхні. Утворення I та II геостратиграфічних підставам М.Ф. Васильєва рівнини терас
ДОЛІНІВСЬКИЙ (середина 2 ОІС, трибасальний, мезологічівський, південно-рівнинський)	15–18	На стадії оптимуму: дернові, дерново-карбовані та близькі до чорноземів ґрунти, на північному заході – корополювальні бурі лісові ґрунтові ґрунти, на сході й південному сході – корополювальні профільні чорноземні, чорноземні лучні, підзоли та каштанові солончаків ґрунти. На жовчаний стадії: бурі степові ґрунти; на сході – бурі пустельно-степові ґрунти	Перевално степові, на півдні – лісові, лісо-степові. Напівкислі на етапі суглинисті, пустельно-степові	+4...+5	+17...+18	-9...-6	df 300–350 df 400–500	
БУЗЬКИЙ (початок 2 ОІС, відр. каліновий, лісові миса, владиславський, долинський)	18–27	Лесні типові та лесоподібні суглинки	Перигляціальні степові та лісостепові	-11	+6...+7	-19...-18	200–250	

Figure 6. The monograph S. P. Doroshkevych “The nature of the Middle Pobuzhya in Pleistocene according to the study of fossil soils” and fragment of the correlation scheme of the natural state of the Middle Pobuzhye in the Pleistocene (Doroshkevych, 2018)

– geological study and rational use of bowels of the earth (quaternary sediment study, paleogeographic prerequisites of the mineral resources formation and accumulation in the context of expanding the prospect of mineral reserves in Ukraine, geological and stratigraphical studies of late Cenozoic deposits);

– Nature Reserve Fund (scientific and educational information on paleogeographic features of nature reserves and individual geological sites of different rank);

– environmental monitoring (assessment of the current state and dynamics of spatial and temporal changes of environmental conditions based on paleogeographical analysis of the content of various substances in soils).

The scientific results obtained in Sector of paleogeography can also be used by various research and educational institutions of geographical, geological, biological and historical directions, nature conservation institutions of Ukraine, state administrations (with archaeologists – study of human living conditions in separate stages the Pleistocene and Holocene of Ukraine; with paleontologists – correlation of data on the history of soil development with vegetation development and other paleontological data; with geologists – the expanding of the mineral resource base of Ukraine; in cooperation with the soil scientists – a study of the history of Holocene soils development), etc.

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