Journal of Geology, Geography and Geoecology

Journal home page: geology-dnu-dp.ua

ISSN 2617-2909 (print)
ISSN 2617-2119 (online)

Journ.Geol.Geograph.
Geology,
28(2), 367–376.
doi: 10.15421/111935

Map of Quaternary formations of Ukraine in scale 1:2,500,000

Yu. Veklych

Ukrainian State Geological Research Institute, Kyiv, Ukraine, e-mail: veklych_um@ukr.net

Received: 05.02.2019
Received in revised form: 08.04.2019
Accepted: 14.04.2019

Abstract. The article announces a new map of Quaternary formations on the territory of Ukraine on the scale 1:2,500,000. It considers the prerequisites for the preparation of this map and summarises more than a century of historical research and mapping of the Quaternary formations on the territory of Ukraine. Due to the continuity of scientific research, an extremely developed theoretical and methodological basis of both research and mapping of Quaternary formations has been formed in the country. This is also due to the extraordinary diversity of the geological structure of the Quaternary cover, due to the presence of two mountain systems, lowland areas (including within them several deflections and two crystalline foundations), as well as due to the presence of two seas (including the continental shelf, slope and deep-water zone). A very wide spectrum of facies and formations is also listed (including a thick loess-soil cover, facies of two glaciers of different ages, alluvia, estuary, marine shelf, deep-water and etc.). Attention is focused on two important problems of mapping Quaternary cover. The first is related to new views on the origin of the subaerial cover. The significance of the new (geo-eolian) factor is disclosed, which determined both the thickness and lithological properties of the strata of each paleogeographic stage (of climatoliths) of each separate section, and the stratigraphic structure of the loess-soil cover. Spatial patterns of the structure of the subaerial cover are briefly described, in particular, the mosaic division into areas with a homogeneous stratigraphic structure (type-sections), due to the corresponding geo-eolian mode (sequence). The second problem concerns the ways of visualization of the geological structure of Quaternary sediments on the map. Two principles of reflection of the Quaternary cover are considered, and the disadvantages and advantages of each of them are indicated. Promising ways to map the Quaternary subaerial cover on the basis of ideas about its mosaic structure are proposed. A solution to the problem of various principles of visualization of the Quaternary cover is recommended involving compilation of «multi-visual» maps based on their interactive re-issuing (re-design) with modern geographic information systems in accordance with various principles of visualization of the structure of the Quaternary. It has been proposed to use the above scientific approaches in the mapping of the Quaternary deposits of Europe and the World, and also to take into account the geo-eolian factor in the studies of the subaerial cover.

Key words: mapping, map of Quaternary formations of Ukraine, subaerial sedimentogenesis.

Карта четвертинних відкладів України масштабу 1:2 500 000

Ю. М. Веклич

Український державний геологорозвідувальний інститут (УкрДГРІ), Київ, Україна, e-mail: veklych_um@ukr.net

Анотація. У статті анонсована нова карта четвертинних відкладів території України масштабу 1:2 500 000. Акцентована увага на двох важливих проблемах картування четвертинного покриву. Перша пов'язана з новими поглядами на походження субаерального покриву. Розкрита сутність нового (гео-еолового) чинника, який визначив як потужності й літологічні властивості стратонів кожного палеогеографічного етапу (кліматолітів) на кожній окремій ділянці, так і стратиграфічну будову лесово-ґрунтового покриву загалом. Коротко описані просторові закономірності будови субаерального покриву, зокрема мозаїчний його поділ на ділянки з однорідною стратиграфічною будовою (типо-розрізи), що зумовлено відповідним гео-еоловим режимом. Друга проблема стосується шляхів візуалізації геологічної будови четвертинних відкладів на карті. Розглянуто два принципи відображення четвертинного покриву, а також вказані недоліки й переваги кожного з них. Запропоновані перспективні шляхи картування четвертинного субаерального покриву на основі уявлень про мозаїчну його будову. Рекомендовано вирішення проблеми різних принципів візуалізації четвертинного покриву шляхом складання «полівізуальних» карт на основі інтерактивного їх переоформлення сучасними засобами геоінформаційних систем відповідно до різних принципів візуалізації будови четвертинного покриву. Запропоновано використовувати наведені наукові підходи при складанні карт четвертинних відкладів Європи та Світу, а також враховувати при дослідженнях субаеральних покривів гео-еоловий чинник.

Ключові слова: картування, карта четвертинних відкладів України, субаеральний седиментогенез.

Introduction. In Ukraine, the mapping of Quaternary formations on a 1:2,500,000 scale of a new generation is being completed (Fig. 1), the results of which will become part of a set of GIS maps of geological content (http://ukrdgri.gov.ua/uk/geo-map). A similar map on the same scale was published in the National Atlas of Ukraine (National Atlas of Ukraine, 2007), but the new map differs significantly in several parameters at once. In particular, it more fully takes into account the geological mapping data for the last 10-15 years, more fully reflects the structure of the bottom of water bodies, and it is based on other principles of research and mapping of subaerial facies, including of loess-soil cover (in the south of Ukraine) and sandy cover in Polissia (in its north).

Already at the beginning of compiling this map, several problems were discovered, each of which affects the content and images of the maps. Within the framework of this article, we will dwell only on two of them, which are important for the content and form of the display of the geological structure on the Quaternary formations map. The first problem concerns the methodology and techniques for the study of Quaternary deposits and is the choice of certain principles of the stratigraphic and facies or genetic classification of parts of the Quaternary cover.

The second problem concerns the principles of reflecting the geological structure of the Quaternary cover, two of which are mainly used at present: 1) «classical-geological» (mapping the first Pleistocene layer from the earth's surface), and 2) «glyptogenetic» (mapping the main geological order of the formation of the Quaternary cover in its manifestations in relief).

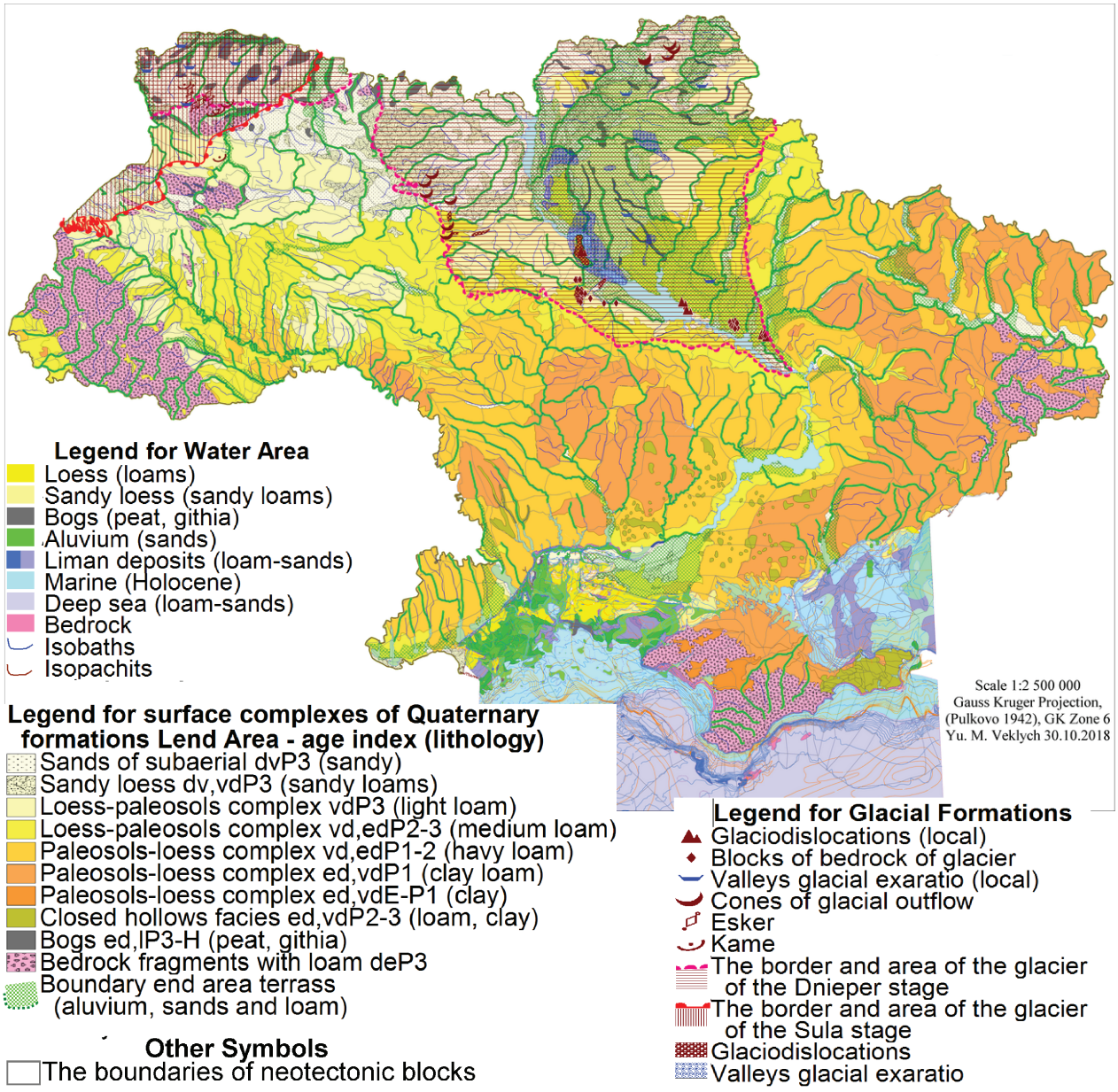

Fig. 1. The map of Quaternary formations of Ukraine, scale 1:2,500,000

First, it makes sense to dwell on the prerequisites that served as the basis for problems in the preparation of this map, as well as ways to solve them. Geological mapping of Quaternary formations in Ukraine has at least several features that are important for understanding the issues under consideration. 1. This territory is characterized by a long history of research and colossal amounts of accumulated factual and cartographic material. 2. The territory is diverse both in the spectrum of continental, marine and submarine facies. 3. About 2/3 of the territory of Ukraine is covered with a thick loess-soil cover. 4. Various aspects of the Quaternary cover and the history of its development have been studied by many prominent researchers. Thanks to the continuity of research, the modern Ukrainian scientific school has acquired an extremely high theoretical and methodological-technical level and depth of substantiation of the basic theoretical positions of periodization and paleogeographic development of different sides and components of the Quaternary.

The history of geological studies of Quaternary sediments in Ukraine extends back for more than a century, and the first Quaternary maps for the entire territory of Ukraine sediments at a scale 1:1,000,000 were compiled in the 1950s-1960s - «The geological map of the Quaternary sediments of the Ukrainian SSR on scale 1:1,000,000», 1954, 1961, 1962 (Sossa, 2002). The increase in the amount of factual material, which due to continuous large and medium scale geological research and mapping, as well as the emergence of new theoretical solutions for detailed dismemberment and age identification of Quaternary formations (loess-soil sequence, alluvial terraces, etc.) prompted the compilation of new versions of Quaternary maps. Such maps were compiled in 1977 (V. Cherednichenko et al., 1978) and in 2000 (B. Vozgrin et al., 2000). The author also took part in the preparation of the latest version.

It should also be added that maps on this scale were compiled based on the results of the state geological mapping on the scale of 1:200,000, which began on the territory of Ukraine in the late 1960s. And after 2000, the program of mapping the new generation of the State Geological Map-200 was launched. This is a set of 3-6 geological maps for several age sections, including with a Quaternary sediment map. Now, new generation maps of Quarternary formations are in the process of completion or have already been completed for more than 4/5 of territories (Fig. 2). Nine regional geological enterprises are engaged in mapping of each of them, the maps taking up more than 190 sheets, using large volumes of field research, drilling, and analytical data. More than six academic and industrial institutes are also involved in theoretical support of these works. In addition to geological mapping, other types of map were compiled within Ukraine (in particular, engineering-geological and hydrogeological mapping), within which the Quaternary cover was also studied in detail. Due to these circumstances, the territory of Ukraine has in the geological sense become one of the most studied regions of the World.

A variety of geological structure. The territory of Ukraine is extremely attractive to researchers of various scientific fields: geologists, geomorphologists, stratigraphers, paleopedologists, paleontologists, geotectonists, paleogeographers, etc. This is due to the extraordinary diversity of the geological structure and the presence of a wide range of genetic types and facies of Quaternary deposits. This peculiarity is also extremely favourable for solving theoretical problems: interfacial and stratigraphic correlations, paleoclimatic and geotectonic periodization, the establishment of spatial and temporal patterns of paleogeographic, biostratigraphic archaeological and other components, as well as the history of the formation of the geological structure of the Quaternary in general.

Within the lowland part, two mountain systems (the Carpathians and the Crimean mountains), and two seas (Black Sea and Azov), the following features are present: 1) loess-soil formation, which covers 2/3 of the territory of the country (which by stratigraphic completeness is similar to Chinese loess formations); 2) subaerial eolian deflationary and accumulative formations (dunes, sandy shafts, hills, ridge relief etc.) in Polissia, in the Oleshkovsky sands, in the valleys of individual rivers, and the like; 3) alluvial terraces, among which some are unique in area (up to 260 km in the Dnieper Valley), in morphology expressed in relief (east-sloping terraces of the Dniester), in location (on the shelf of the Black and Azov Seas), in the reorganizations of river networks (numerous «hanging», «dead», etc. valleys, interception of rivers by one another, etc.); 4) glacial formations of two different glacial ages - of Middle Quaternary and Early Quaternary (various types of moraines and morenoids, erratic block, glaciodislocation, valleys of plucking and erosion, kames, eskers, etc.); 5) mud volcanoes and their deposits are distributed both on the land territory (Kerch peninsula, Carpathians), and in the aquatoria (Black and Azov Seas); 6) marine and coastal (estuary) facies and terraces are common both on the coast and within the aquatoria of the above seas, there are also facies of the continental slope and

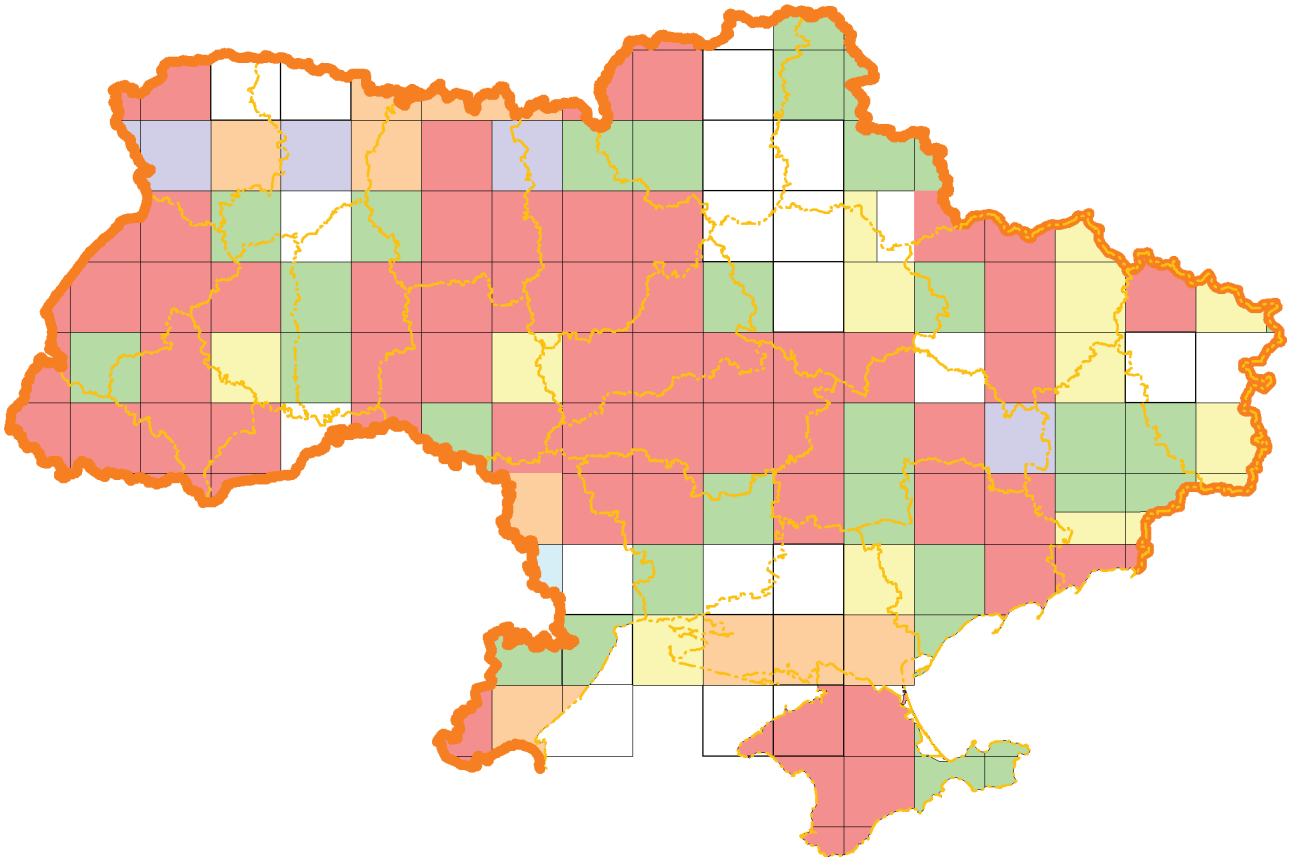

Fig. 2. Cartogram of the geological mapping of Ukraine by program State Geological Map-200 of new generation (2000-2018)

of the deep water part of the Black Sea; 7) the facies of lakes and marshes; 8) the facies of closed depressions (areas of salinization and subsidence loess); 9) cave facies associated with gypsum and carbonate karst; 10) chemogenic travertines; 11) various facies of mountain regions (the Crimean mountains and the Carpathians); 12) volcanic facies in the form of small interbeds of volcanic ash (volcanic activity on the territory of the Ukrainian Transcarpathia was completed approximately 7 million years ago); 13) places of natural seepage of liquid hydrocarbons onto the surface (the Carpathians, Kerch Peninsula); 14) and, finally, bedrock on the surface - the regions where the Quaternary cover is completely absent.

To this should be added a large saturation of sediments with paleontological remnants (especially of subaqual facies), as well as the uniquely detailed record of changes in the paleo-ecological settings of the Mediterranean-Black Sea-Azov-Caspian of sea system. All this over the past decades has turned the territory of Ukraine into a kind of Mecca for researchers of various aspects of the Quaternary.

Theoretical and methodological basis of research and of mapping of Quaternary sediments in Ukraine. Within the framework of this article, it makes sense to dwell only on the current Ukrainian scientific direction of Quaternary research, but it is worth noting the hundreds of prominent scientists whose research results form the foundation of the modern theoretical foundation.

The Ukrainian scientific direction of research on the Quaternary was founded by M. F. Veklych (since 1968) and supplemented by like-minded colleagues and followers. It is represented by an extensive system of theoretical, methodological, and technical principles and positions. This system (paleogeographic approach) includes several components in particular: the «Documentary approach», the «principle of Stages», «Neotectogenesis», «Geoeolian morpholithogenesis» and the «Scheme of periodization and detailed stratigraphy of late Cenozoic Ukraine». (Veklych, 2018). The latter is based on paleoclimatic principles and covers the age range from the present to 7 MA. The Paleogeographic approach has a lot of differences from the generally accepted principles and approaches of both periodization and the study of the Quaternary, and therefore it may be of interest to researchers both as an alternative point of view on the initial principles and as providing additional methods for research into the Quaternary. The theoretical foundations of the Ukrainian scientific field are described in detail in a series of monographs and

articles (M. Veklych, 1982 and etc.; Zh. Matviinyna, 2013-2018; N. Gerasymenko, 2013-2018, Yu. Veklych, 2011\a, 2011\b, 2018 and etc.).

Only certain provisions of the paleogeographic approach concerning the problems of mapping Quaternary formations are considered below. In particular, the question of the genesis (the origin) of loess-soil covers and of sandy facies of the palaeo-deserts turned out to be important.

Quaternary cover mapping problems. There are two problems that significantly affect the result of the mapping of Quaternary formations, including the contours and the colouring of map objects. Both concern mainly the subaerial cover of both loamy (loess-soil) and coarse-grained (sandy, stony) composition.

Geo-eolian morpho-lithogenesis. The first problem is connected with a new point of view on the origin of the loess, as well as of loess-soil cover and of cover without loam. It significantly changes the view on the formation of the Quaternary cover, including the formation and structure of Quaternary covers, the origin of the subaerial facies of different lithological composition, as well as the spatial differentiation of the Quaternary cover by genetic, lithological and stratigraphic composition and the like. A detailed description and justification of this phenomenon are given in a separate monograph (Yu. Veklych, 2018), therefore, only its basic provisions are given here.

According to the results of years of research and multi-scale mapping of Quaternary formations of the territory of Ukraine, the author identified several phenomena that could not be explained within the framework of generally accepted ideas about geological (paleogeographic) processes and factors (including ideas about loess origin).

Using the example of one of the loess islands, it was established that the presence or absence of loamy (loess-soil) cover in certain areas cannot be explained by the prevailing wind flows, nor by any of the known geological factors. By all indications, the presence of such cover is determined by the properties of the earth's surface in these areas to attract (from the air) atmospheric dust. Similarly, the absence of loam cover at the regional level is due to the push away of small (dusty and clay) particles from such sites. In Fig. 3, using the example of the Ovruch loess island, the principle of the redistribution of tiny grain particles in the accumulation of loess strata (afflationary conditions) and deflationary landscapes (deflation) is shown.

Further studies have established that the earth's surface is divided into a continuous mosaic of areas that during the Quaternary had different geoeolian regimes (modes, sequences). The differences in the geoeolian regime of each such region were determined by the individual sequence of stages of accumulation of atmospheric dust or deflation processes. In the case of predominance of accumulation of atmospheric dust, loess-soil covers were formed, whereas in areas

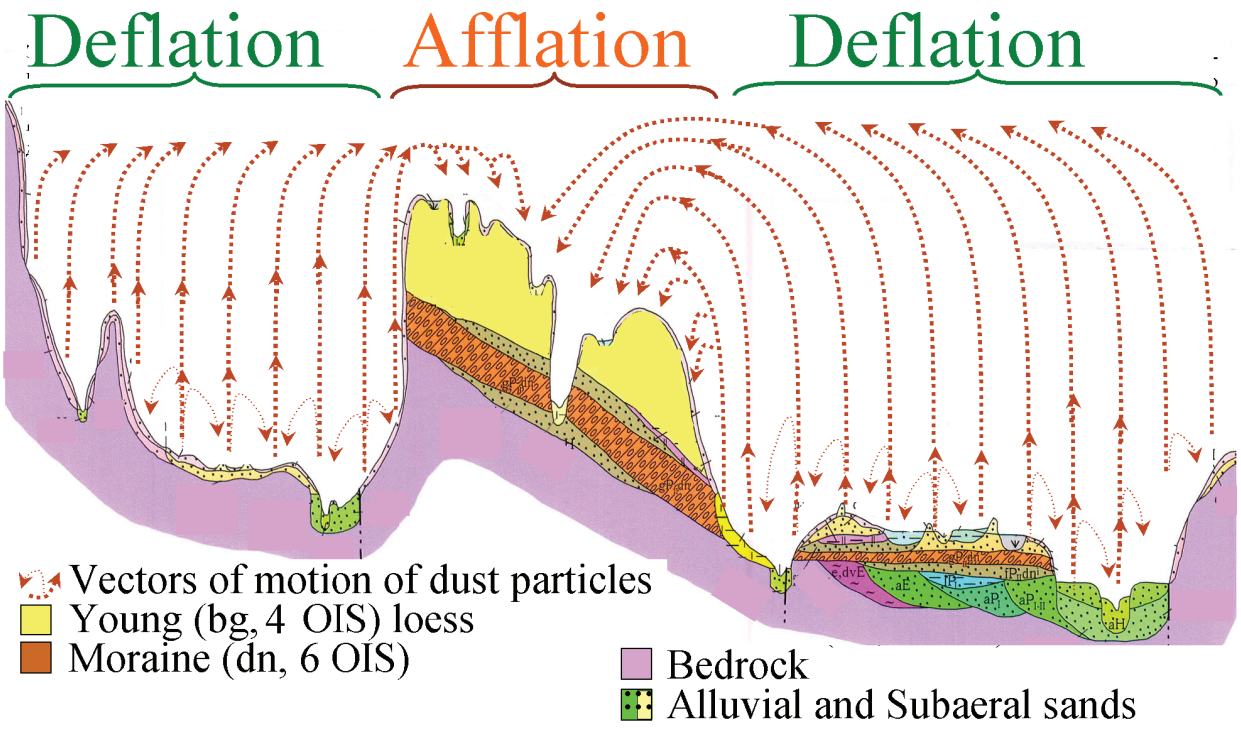

Fig. 3. The principle of geo-eolian redistribution of dust on the earth's surface (on the example, the accumulation of loam Ovrutsky loess Island and the formation of deflationary sand cover around it during the bedrock stage ,4 OIS)

with deflationary conditions (only for particles less than 0.25 mm), cover without loam (sandy, coarse grained, or no Quaternary cover at all) was formed.

Furthermore, the geological factor determines the thickness, the lithological composition, and the stratigraphic structure of each section. Thus, within the limits of the predominance of deflationary conditions, thin sand coverings were formed, while thick clay-loamy loess-soil covers formed on the dust deposition sites. Polissia (in Fig. 1 light coloured areas in the north of Ukraine) is a vivid example of the prevalence of deflationary conditions in the Quaternary, where landscapes with a thin sandy Quaternary base were formed. The loess regions of the central and southern areas (Fig. 1, yellow and brown coloured) reflect a mosaic of areas with a predominant accumulation of atmospheric dust.

Studies show that the geoeolian rhythm differs from the climate rhythm (which is the basis of the periodization and stratigraphy of the Quaternary). And if a deflationary mode was established on the territory for one or several climatic rhythms, then these rhythms «drop out» of the cut, because they lost the medium of their reflection. That is, a regional stratigraphic break has formed within such territories. The age range of such stratigraphic breaks generally matches the duration of the «non-accumulation» of atmospheric dust, and this provided a methodological basis for the study of the «temporal» aspects of geoeolian litho-morphogenesis.

An analysis of the spatial and temporal differences of the geoeolian factor in different territories confirmed the heterogeneity of the loess-soil cover. It was established that the seemingly homogeneous loess-soil cover on the territory of Ukraine is actually a mosaic of areas with a different climatic- stratigraphic structure. The loess-soil cover of each element of this mosaic is characterized by its own «type-section», which has a stratigraphically homogeneous area of loess-soil cover- with the same power ratio of climatoliths and the same stratigraphic interruptions, making it easy to recognize in each section.

There are also established general patterns of sequences of abrupt changes in direction or (deflationary or afflationary conditions) and the intensity each of these geoeolian regimes. In particular, the same age of the boundaries between sharp changes in geoeolian processes, that is, their belonging to certain palaeoclimatic stages, was traced. On the basis of the analysis of numerous factual materials, a geoeolian and phased scheme has been compiled, which reflects the temporal patterns of qualitative relative changes in all possible geoeolian regimes. This scheme makes it much easier to determine the geoeolian regime, by the stratigraphic structure of loess cover, as well as to clarify the boundary between regions with different geoeolian regime.

Without a doubt, all other geological factors and processes (fluvial, deluvial, gravity, etc.) are also acting, and all geological phenomena and objects that are characteristic of traditional Quaternary geological maps will also be present on the new map. However, it should be noted that the results of the action of most of these factors differ significantly for the accumulative (afflating) or deflationary regions. In deflationary sandy Polissia, deluvial, proluvial, alluvial, colluvial, and other facies have a sandy or coarse-grained composition, whereas in afflation-loess regions these facies are loamy or clayey (Yu. Veklych, 2018).

Of course, such significant differences in views on the formation of subaerial Quaternary cover significantly affect the principles of its mapping. This applies to both the zoning procedures and contours of the Quaternary cover, as well as their content and colouring.

On the principles of display on the map of the Quaternary formations. Modern GIS-technologies have almost unlimited possibilities for displaying and analyzing geospatial information, but, in one way or another, the final result is a map that displays (drawing) a system of elements arranged according to certain display rules. Even in the case of compiling a «poly-visual» set of maps of the same content, when maps of map objects can be interactively changed by automatic renewal using one or another display principle (for example, interactive replacement of symbol sets with GIS-tools), it is necessary to algorithmize each of these principles. Creating a single map of Europe or the World also requires some agreement between the authors of the principles of reflection of the final map (even if there are several such principles). All this forces us to examine in more detail the existing approaches of visualization of the geological structure on the maps.

The following is an analysis of the basic principles of the cartographic display of Quaternary deposits, which are most often used in mapping, as well as a new principle that allows one to a certain extent to combine their positive properties.

The analysis of the long-term experience of mapping of the Quaternary deposits of the territory of Ukraine revealed at least two quite distinct principles of displaying the Quaternary cover. Their difference relates to the main object of the mapping of the Quaternary cover. Consider the main differences

between the previously mentioned glyptogenetic and classically-geological mapping principles of Quaternary cover.

In 1977 and 2000, maps of Quaternary deposits of Ukraine were compiled, illustrating both the above mapping principles. In Fig. 4 for comparison, two images: «a)» the 1977 map (V. Cherednichenko et al., 1978) illustrates the mapping result according to glyptogenetic mapping principle, and «b)» the 2000 map (B. Vozgrin et al., 2000) is an example of

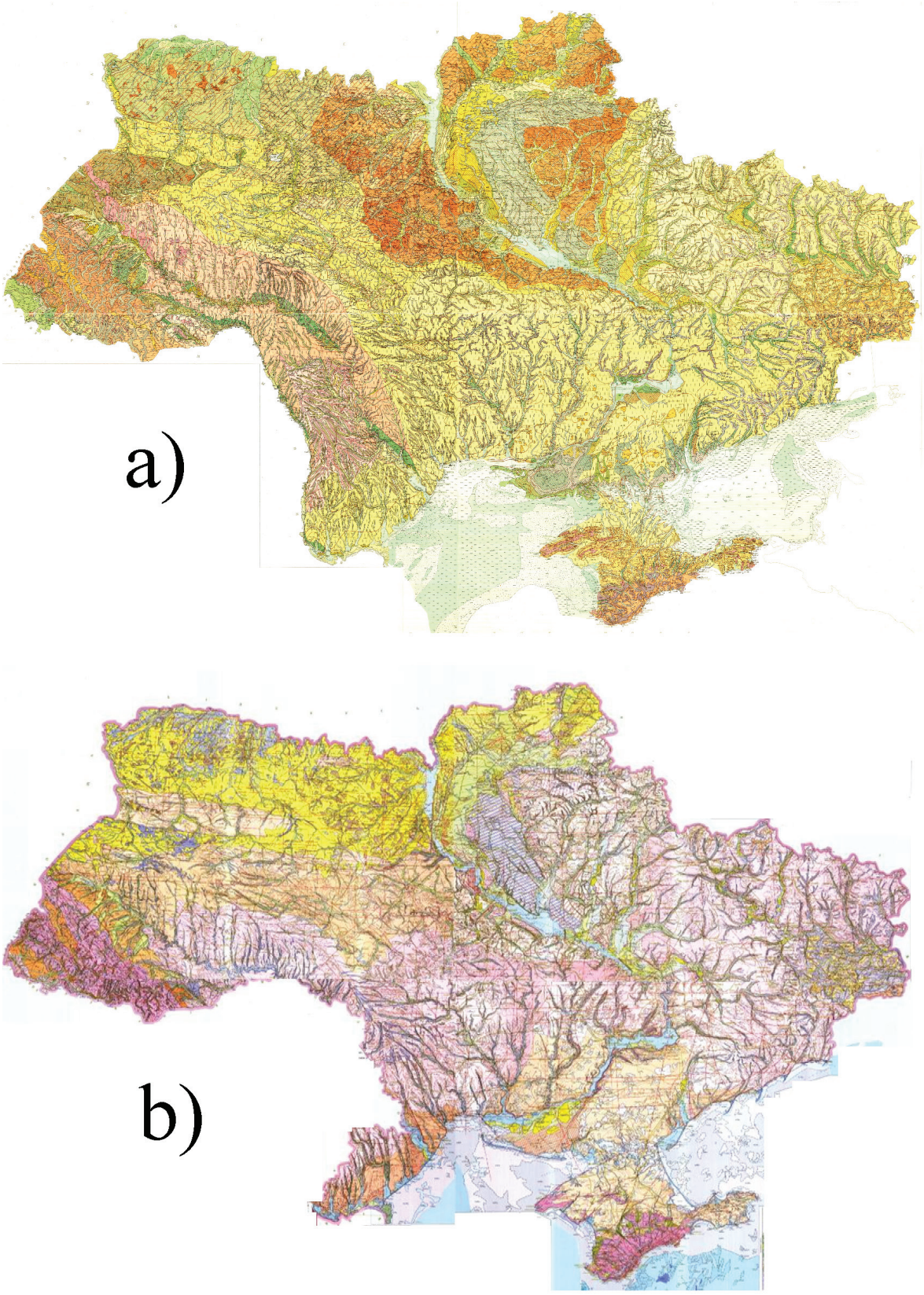

Fig. 4. Examples of two principles of visualization of the geological structure on the maps of the Quaternary formations of Ukraine: a) - glyptogenetic (1977) and b) - classic-geological (2000)

applying its classic-geological principle. As you can see, these maps are very different in terms of contours and fill. It should be noted, however, that the number of cartographic objects and in many respects the contours on both maps are generally the same, but the same objects (for example, deposits of glaciers, alluvial deposits) are in one case represented by colour, and in the other represented by contours.

On maps of 1:1,000,000 scale (a decade earlier and 1:200,000), the criterion for establishing the main mapped object was the determinative geological factor that conditioned the main features of the geological structure of a particular site. To this principle of mapping of the Quaternary sediments, we have the given code name «glyptogenetic» by E. F. Shantser, who coined this term in wide use. This approach is justified for small-scale and medium-scale mapping, as well as for areas with insufficient geological study. The geological content of areas of such a map are determined by individual sections (support, etc.), and their contours are predominantly geological (more precisely, glyptogenetic) principles. This allows one even in the conditions of a small number of sections studied to recreate the contours of the main geological factors - of the ancient glaciers, river terraces and the like.

A striking example of this approach is the reflection of glacial and alluvial sediments on the 1977 map. As can be seen (Fig. 4, «a)»), the loess cover is «removed», although it covers glacial (and sometimes alluvial) deposits, that is, reflected on the map only by contours. But the distribution areas of the buried moraine, as well as alluvial deposits of the terraces, are shown in colour. Most of the maps of the Quaternary formations of the first generation (« State Geological Map-200») are compiled precisely on this principle. A positive feature of this principle is that it focuses attention on the main morpho-lithogenetic features of the geological structure. Their disadvantage is that the information about the near-surface layer of the Quaternary cover (which is important for human activity) is reflected by specks, contours, or not drawn at all on the map.

Another feature is the fact that this map reflects the facies or genetic types of the beginning of the formation of the Quaternary cover and relief (fluvial terrace-formations - green colour, surface glaciers - brown colour, etc.). That is, such a map displays mainly the subface of the Quaternary cover, that is, so to say «bottom view». With this approach, compromises are often necessary, for example, in the case of several «floors», for example, when the moraine is located on alluvium and is overlapped by the loess. The loess-soil cover of the extra- glacial territories on such maps as an exception is depicted mainly «from above» (under the modern soil). Exceptions are also subaqual facies of the Holocene age, the age equivalents of which are «removed» in subaerial segments.

In Ukraine, from the 1970s-1980s, a new principle of Quaternary cover mapping was developed and introduced, which is called ***«classic-geological»***. This principle is the basis of the 2000 map (the image «b» in Fig. 4) is applied on all large-scale maps (including the new generation map «State Geological Map-200»). Its provisions are borrowed from the principles of classical geological mapping that is, mapping of outputs to sub-Quaternary or surface of pre-Quaternary sediments. But in our case, it consists in the reflection of the first pre-Holocene Quaternary strata from the surface or the strata complex. This approach focuses attention on the near-surface layer of the Quaternary cover, which is important for human activity. As can be seen from Fig. 4 (the image «b)»), on this map soil-loess (yellow colour) and loess-soil (pink colour) formations prevail. Buried deposits of other morpho-genetic factors (moraines, alluvium and marine sediments) are indicated by contours, or symbols.

The basis of the contours of the individual Quaternary areas of the new generation map is taken from the data of the lithological (granulometric) composition of the maps of modern soils. The sharp boundaries between the plots with different such composition simultaneously display the boundaries between the plots with different facies-stratigraphic structure of the Quaternary cover. This approach significantly increases the objectivity and reliability of the map, since lithological data are obtained on the basis of analytical studies. But the «filling» of the geological content of each site selected in this way is a real scientific study, which requires a high scientific potential, as well as a sufficient amount of field work with detailed stratigraphic and age identification of many geological sections.

Of course, such an approach requires a much denser network of geological observation points, each of them needing a detailed stratigraphic division. This was made possible thanks to the high level of the theoretical and methodological and technical base in Ukraine, as well as the introduction to the level of regional geological enterprises within the framework of the current program State Geological Map-200 of new methods for stratigraphic subdivision of loess-soil sections and the age identification of other phenomena of the Quaternary (terraces, facies etc.).

Maps compiled according to the classical-

geological principle have their drawbacks. Thus, some of the most important facets of the Quaternary cover here are depicted by lines or symbols and look like minor ones. However, there is no doubt that new generation maps are more reliable and informative than previous ones.

And finally, a few words about the ***new principles of Quaternary sediment mapping***. New ideas about the spatial separation of the Quaternary cover, taking into account the geoeolian regime, suggest that it is necessary to introduce additional criteria for this mapping. And the fact that it is this factor that determines the basic characteristics of most other facies (namely, the lithological composition, thickness and stratigraphic completeness) gives it a special meaning. Of course, all the traditional components of Quaternary cover (alluvium, moraine, proluvium, deluvium, etc.) should be on the map. However, additional regionalization of the new principle significantly increases the value and reliability of such a map, expands and deepens the understanding of the essence of the paleogeographical formation of Quaternary cover and relief.

The introduction of the concept of a type-section also opens up new paths for the compilation of a legend. Now a two-level legend is being developed, in which each colour symbol of the map is accompanied by a quasi-stratigraphic column, in which the full structure of the Quaternary cover is revealed. This column reflects the genetic stratigraphic information for each climatic stage (genetic type or facies, as well as its frequency of presence in the sections of such an area. This principle of compiling a legend has excellent prospects, especially when applying modern GIS-technologies. In particular, such an approach makes it possible to map not only the stratigraphic-genetic complex, but also the stratographic-genetic features of the sediment of all climatic stages, and volumes of stratigraphic breaks. The combination of such detailed stratigraphic-genetic and spatial information with the capabilities of GIS-technology provides for the possibility of creating interactive maps in which you can achieve instantaneous renewal of maps according to the mentioned glyptogenetic and classical geological principles. Furthermore, the availability of information on each climatolith of each selected (mapped) area (type-section) turns such a GIS map into a visualization tool for each climate stage, as well as for individual genetic divisions and much more. At present, the question has been raised about the creation and use of such an information environment for automatic interactive translation of maps from one scale to another, taking into account stratigraphic and genetic detailing or generalization.

Conclusions. Mapping the Quaternary formations of Ukraine with a scale of 1:2,500,000 facilitated improvement of new approaches to the study of the geological structure and deep analysis of aspects of its cartographic visualization. New ideas about the formation of the subaerial Quaternary cover (taking into account geoeolian processes) and its spatial discretization into areas with a homogeneous stratigraphic structure (type-sections) reveal new approaches in its mapping. In conjunction with modern information technologies (including GIS) in the field of geological mapping , a qualitatively new basis for the implementation of these tasks is formed. Among other solutions the formation of maps with the possibility of interactive redrawing and visualization by several different principles is attractive.

After publication on the GEO-site, the announced map could supplement the general Quaternary map of Europe and the World. Despite the fact that the compilation of these (general) maps is at its peak, given the above, the prospects for improvement are far-reaching. In this regard, even before the completion of these projects, it would be advisable to intensify the public discussion with a view to sharing experience and agreeing on the principles of cartographic visualization of formations and deposits of the Quaternary.

References

Cherednichenko V. G., Pasechnyy G. V., Zhukov D. M., Yartseva E. A., Abashin A. A., 1977. Karta chetvertichnykh otlozhenii Ukrainskoi SSR y Moldavskoi SSR masshtaba 1:1 000 000. [Map of Quaternary deposits of the Ukrainian SSR and the Moldavian SSR in scale 1:1 000 000] 4 sheets of map + explanatory note (in Russian).

Natsionalnyi atlas Ukrainy, 2007. Hol. red. B. Ye. Paton. [National Atlas of Ukraine / National Academy of Sciences of Ukraine]. - Kyiv, DNVP «Kartohrafiia», 440 p. (in Ukrainian and English).

Sossa R. I. 2002. Kartohrafichni tvory na terytoriyu Ukrayiny (1945—2000 rr.): bibliohrafichnyy pokazhchyk [Cartographic works on the territory of Ukraine (1945-2000): bibliographical index]. - Kyiv: DNVP «Kartohrafiya», 400 p. (in Ukrainian).

Veklych M. F., 1982. Paleoetapnost y stratotipy pochvennykh formatsii verkhneho kainozoia [Paleogeographic Staging and stratotypes of Upper Cenozoic soil formations]. - Kyiv: Nauk. dumka, 208 (in Russian).

Veklych Yu. M., 2018. Heoeolovyi morfo-litohenez ta metodolohichni aspekty yoho doslidzhennia [Geo-

eolian morpho-lithogenesis and methodological aspects of his research]. - Kyiv, UkrDGRI, 254 (in Ukrainian).

Veklych Yu., 2011. Karta chetvertynnykh vidkladiv Ukrainy novoho pokolinnia. Stattia 1. Stan pytannia, informatsiini resursy ta nahalni problemy [Quaternary sediment map of Ukraine of a new generation. Article 1. State of the Question, Information Resources and Urgent Problems]. Zbirnyk UkrDGRI, №1 (2011), 50-67 (in Ukrainian).

Veklych Yu. M., 2011. Karta chetvertynnyh vidkladiv Ukrayiny novogo pokolinnya. Stattya 1. Stan pytannya, informacijni resursy ta nagal`ni problemy [Quaternary sediment map of Ukraine of a new generation. Article 2. The paleogeographic approach - the basis of mapping of the Late Cenozoic]. Zbirnyk UkrDGRI, №3 (2011), 50-69 (in Ukrainian).

Vozghrin B. D., Pedanuk G. I., Demekhin L. O., Solovitsky V. M., 2000. Heolohichna karta chetvertynnykh vidkladiv Ukrainy. Masshtab 1:1 000 000. [The map of Quaternary formation of Ukraine. Editor. P. F. Gozhik.]. - UkrDGRI. 4 sheets of map + explanatory note 367 (in Ukrainian and English).