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Geological journeys of Valerian Domger to the basins of the rivers Omelynyk, Samotkan and Domotkan

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Abstract. This article covers only a small but significant part of the territory of the former Katerynoslav and Kherson governorates, where Valerian Domger made his significant geological explorations between 1881 and 1884 on the commission of the Geological Committee. Here, 70 years after

the discovery of a unique mineral deposit, one of the world's richest deposits of titanium-zirconium ore, was discovered. This article presents the results of analysis of the research made by the prominent geologist Valerian Domger, acknowledges the scientific and historical value of his proceedings; covers the main biographical facts of this researcher of the geology of the Middle PreDniproviya region; emphasizes the details which are less familiar and seldom mentioned in the literature; covers the analysis of Domger's route across gullies, ravines and rivers, where he travelled to compose a 10 verst map for the project of constructing the Katerynynska railway. These journeys became the basis for all further studies in the region. This paper proves the fact that V. Domger was the discoverer of the world's largest deposits of manganese ore; evaluates the results of Domger's studies of the valleys of the rivers Omelynyk, Samotkan and Domotkan – these works were first to provide data on the structure of pre-Cambrian crystalline basement of the Ukrainian shield, its petrography and the mineralogy of its rocks. The study revealed important patterns in the structure of the sedimentary Paleogene-Quaternary cover; defined Domger's role in determining the stratigraphic position of the Mandrykivski layers, which he discovered in 1882 during the construction of the railway bridge across the Dnieper. He was first to assign an Upper-Eocene Epoch for the Mandrykivska fossil fauna, which later would for a long period of time be considered Oligocene fauna. Using the works by prominent paleontologists Deshayes, Nyst, Wood and Michelin, Domger did immensely significant work on the Mollusca fauna. The paper analyses Domger's view on the role of continental glaciations in the formation of Quaternary loess cover in the Middle PreDniproviya region. The researcher also wrote on the Kryvorizke iron ore deposits. His works on analysis of geology of the basins of the Saksahan and Ingulets rivers contributed to the beginning of exploitation of these deposits. Using particular examples, the paper analyses the current condition of the stratigraphic divisions of the different age associations which are mentioned in the works of V Domger; evaluates the significance of Domger's research and the possibility of using it during geological surveys and monitoring of the most significant objects of geological heritage.

Key words: Domger; geology; Geological Committee; Eocene; Mandrykivski layers; geological routes; paleontology; Domotkan; Paleogene; pre-Cambrian Epoch; geological sites

Геологічні подорожі Валеріана Домгера у басейнах річок Омельник, Самоткань та Домоткань

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Резюме. З великої геологічної подорожі, проведеної за дорученням Геологічного комітету Валеріаном Олександровичем Домгером з 1881 по 1884 р. в межах колишніх Катеринославської та, частково, Херсонської губерній, висвітлено її невелику, але важливу частку. Саме тут, через 70 років після маршрутів В. Домгера, відкрито унікальне, одне з найбільших у світі за запасами, розсіпне родовище титан-цирконієвих руд. Наведено результати аналізу досліджень видатного геолога Валеріана Домгера, якими доведено наукову та історичну цінність праць ученого. Розглянуто основні факти біографії дослідника геології Середнього Придніпров'я з акцентом на маловідомі і погано висвітлені у літературних джерелах. Проаналізовано маршрутні подорожі В. Домгера за мережею ярів, балок і річок, що здійснювалися у зв'язку з будівництвом Катерининської залізниці та складанням десятиверстної карти та якими було закладено підґрунтя всіх подальших геологічних досліджень у регіоні. Доведено роль В. Домгера як першовідкривача найбільшого у світі родовища марганцевих руд. Оцінено результати маршрутів В. Домгера, проведених у долинах річок Омельник, Самоткань і Домоткань, завдяки яким

отримано перші відомості щодо будови докембрійського кристалічного фундаменту Українського щита, петрографії і мінералогії порід. Установлено важливі закономірності будови осадового палеоген-четвертинного чохла. Визначено роль В. Домгера у встановленні стратиграфічного положення мандриківських верств, уперше відкритих ним у 1882 р. під час будівництва залізничного мосту через р. Дніпро. Саме він вперше обґрунтував верхньоєоценовий вік мандриківської викопної фауни, яку в подальшому, впродовж багатьох років, помилково розглядали як олігоцену. Керуючись працями відомих палеонтологів Deshayes, Nysta, Wooda та Michelina, В. Домгер дає чудові визначення моллюскової фауни. Надається аналіз поглядів В. Домгера щодо ролі материкових льодовиків у формуванні четвертинного лесового покриву в Середньому Придніпров'ї. Не обминув увагою дослідник і майбутнє Криворізьке родовище залізних руд. Його роботою із обстеження геології басейнів річок Саксагань та Інгулець прискорено залучення родовища до експлуатації. На конкретних прикладах розглядається сучасний стан вирішення питань стратиграфічного розчленування породних асоціацій різного віку, які згадуються у працях В. Домгера.

Ключові слова: Домгер; геологія; геолком; еоцен; мандриківські верстви; геологічні маршрути; палеонтологія; Домоткань; палеоген; докембрій.

Introduction. Dnipro and the cliffs, and the draws and rivers that flow from Gradizhsk to the north to the Velyki Lug (Great Meadow) in the south, remember the geological journeys of the famous geologist Valerian Domger (Fig. 1).



Fig.1. Valerian Domger

Valerian Oleksandrovykh Domger was born in 1851 and lived a short but bright life. His most significant research was related to Southern Ukraine. After completing a course at the Mining University in 1873, V O Domger on behalf of the Mining Department worked on geological investigations in the west part of ore-bearing crystalline belt of Southern Russia. The following year, together with Professor M P Barbot-de-Marni, Domger travelled as a part of a scientific mission conducting geological investigation along the line of the Orenburg Railroad. Since then, till 1882, Domger`s research was related to the line of the railroad which was being constructed. In 1887, he worked within the western part of the Ural Railroad; in 1878 – along the line of the Donetsk black coal road; in 1879 and 1880 – along the line of the Mariupol Railroad and in 1881 and 1882 – along the line of the Katerynoslav (Kryvyi Rih) Railroad. In 1882, Valerian Olexandrovykh was appointed to a job as a junior geologist

at the Geological Committee and over the last two years worked in compliance with the programme of the Committee, and investigated the territory of 47-sheet ten verst map of the European part of Russia within Katerynoslav and Kherson governorates. M A Sokolov, prominent researcher of Southern Ukraine and the best specialist in geology and paleontology of tertiary deposits, wrote of Domger: “Personally, I was hardly familiar with this amazingly humble researcher, who hated exposing himself, but after becoming closely familiar with the diaries of his geological studies in the South of Russia, and with the items he collected in those excursions, I was left with an enormous amount of respect for the extreme scrupulosity and the incredible powers of observation with which he conducted his work, and for his exemplary fervour in striving to shed light on obscure geological questions within the studied territory. This indicates his passion and true commitment to his work” (Sokolov, 1894). Probably these character traits helped Domger to accurately study every ravine, every gully, every outcrop across a large territory, collect and due to lack of time, only partly, analyze mineralogical and paleontological collections, describe all the manifestations of minerals, and even the least significant signs of them, and publish significant scientific articles (Domger, 1882, 1884, 1902). In 1883, while working on the ten-verst map of European Russia, Domger discovered surface outcrops of manganese ore in outcrops around the Solona river (tributary of the Bazavluk river) (Domger, 1884). Using a row of shafts, Domger determined the distribution of “ore bearing horizon across almost 7 versts” and confirmed the metallurgical significance of these minerals using chemical analysis, which confirmed the presence of manganese ore in the area of the Solona river. Domger reported this in the “Vestnik” of the Geological Committee in 1884 (Domger, 1884). Apart from rich manganese ores, Domger discovered a unique location of fossil sea fauna, of Upper-Eocene Epoch. Its variety still attracts paleontologists from different countries. The Mandrykivski layers containing this fauna have

outcrops only in Dnipropetrovsk and are studied by scientists from Russia, France, Germany and other countries (Müller & Rozenberg, 2003; Bitner & Müller 2017). On 10 January 1885, V O Domger unexpectedly passed away in St Petersburg. He passed away aged only 33, at the peak of his scientific and creative activity.

Materials and methods. Since 1984, the author of this article has taken part in geological surveying within the territory where Valerian Domger travelled. Also, in 2003, the process of inventorising the objects of Ukraine's geological heritage was initiated. The geographical range of the objects investigated by the author covered East Ukraine including Dnipropetrovsk Oblast. The method of describing each geological relic included analyzing historical references on the study and consequence of studying each object. The research by V Domger

became the basis for both further geological survey and exploration. With very few exceptions, practically all outcrops which are important for understanding the geological structure of the region are mentioned in Domger's research, which is an impressive testimony to the researcher's curiosity and is relevant even nowadays. Both geological survey and field study of the objects involved analysis of the routes taken by V Domger and determining the objects' contemporary condition and stratigraphic position (Bezvyunnyi et al., 2007).

Results. Part of the territory in what is nowadays Verhnodniprovskiyi district was studied by V Domger in summer seasons of 1881 and 1883 (Fig. 2). The work conducted was related to the construction of the Katerynynska (Kryvorizka) Railroad and creation of a ten-verst geological map of 47 sheets (Fig.3).

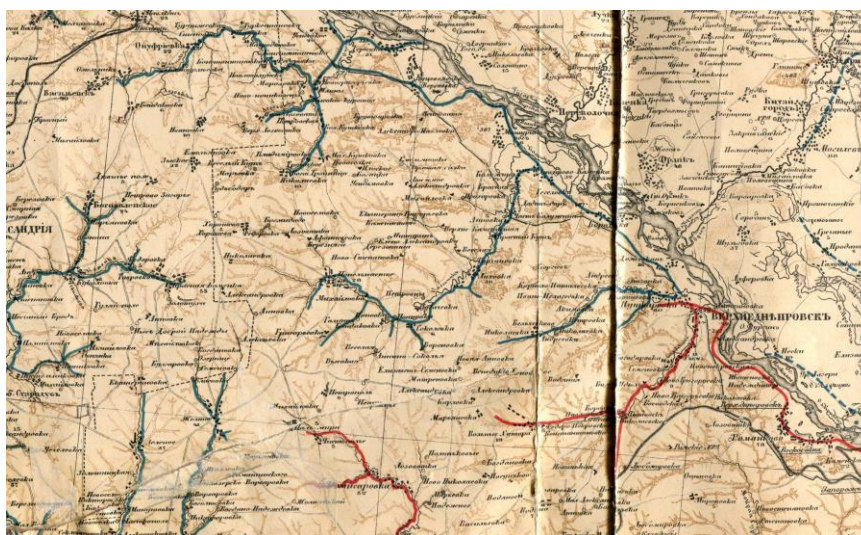


Fig.2. Fragments of Domger's map with 1881 and 1884 routes

It is hard to imagine how in the transport conditions back then, one man could in a relatively short period of time cover such a large amount of routes across the Katerynoslav region, investigate every ravine, describe numerous outcrops of different age. It should be mentioned that his studies, his discoveries are nowadays not only of historical significance, as is often acknowledged, but likewise they determined the future role of our Podniprovia. His achievements include the discovery of the world's largest deposits of manganese ores, the Man-

drykivskiyi basin, found while surveying the valley of the Solona river; and also the discovery and evaluation of the so called Mandrykivska fossil fauna complex in the Upper Eocene sediments, which was later considered the best in Europe (Domger, 1882, 1884, 1902). It contains well preserved Bivalvia moluscs and gastropods, various corals, Bryozoa, sea urchins, sponges, teeth of sharks, etc (Fig. 4)

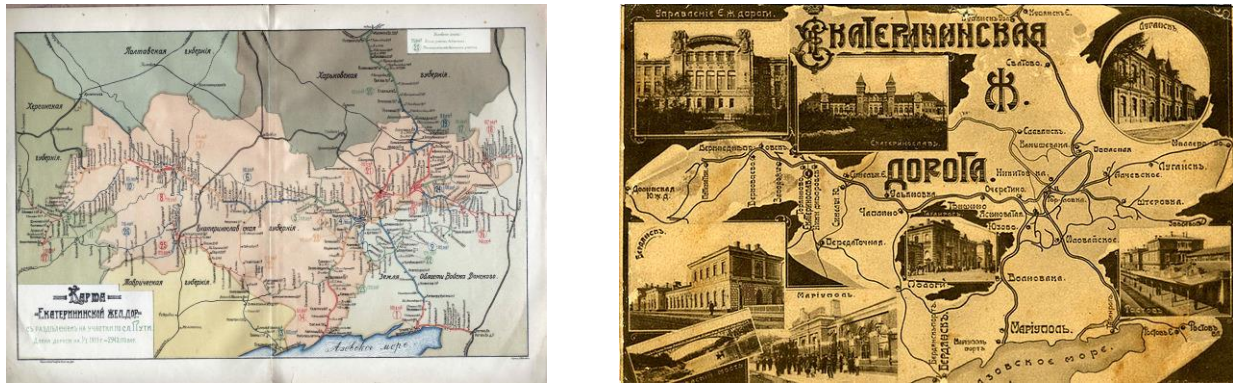


Fig. 3. Katerynynska Railroad (a - on the map; b - on a postcard)



Fig. 4. Fossil Mollusca and a tooth of shark from Mandrykivski layers of Upper-Eocene Epoch

Also along with V Zuev, M P Barbot de Marni, I A Gldenstdt, S O Kontkevych, M F Faas and others, Domger played one of the leading roles in discovering the Kryvorizkyi iron ore basin. On the route along the Dnieper from north-west to north east, V Domger in 1883 visited the valley of the Suhyi Omelnyk river, which at the time crossed through the lands of Oleksandrivskyi powiet of Kherson governorate; his later objects of study were the rivers and ravines of Verhniodniprovskyi powiet, in particular: the Omelnyk, Domotkan and Samotkan. At the head of the river Suhyi Omelnyk, Domger noticed a giant granite boulder of mysterious origin. Despite the fact that after publications

by Jean Louis Agassiz (1840) on the possibility of continental glaciations most scientists in Europe considered the so-called erratic rocks to be of glacial origin, Domger it seems was not interested in these issues and was not an enthusiast of Quaternary glacial rocks. Therefore he writes: "In the same river (Suhyi Omelnyk), near the second pond, opposite the former distilling plant, on a slope of the right side, there is a giant rock of pinky medium-granular granite. Where from and how was it transferred here is a mystery, but no doubt, it was not moved here by a human" (Domger, 1884) (Fig. 5).



Fig. 5. Domotkan erratic boulders

The second significant evidence of glaciation located in the area of the Kupivata river, was also not considered by Domger to be related to glaciation, as is clearly seen in his description: "In one of the deep gullies which falls into the Kupivata river in Volodymyrivka village, there is the following outcrop: below there is a large, up to seven sazhen 2,13 (14,9 m) thickness, layer of white sand with a up to one arshin (0,7112 m) deep layer of sand on it, which contains fractions of different minerals and sandstones, quartzite and also boulders of glauconite sand, filled with fossil shells of *Cardium*, *Lucina*, *Ostrea* and others". No doubt, this refers to fluvio-glacial deposits, formed by water flow during the melting of the Dniprovskiy glacier around 250 thousand years ago.

Good knowledge of paleontology allowed Domger to identify the Upper-Eocene Epoch of fossil Molusca in clayey boulders, which put him ahead of his time M O Sokolov, notable geologist and paleontologist, in his work devoted to Domger ((Sokolov, 1894), mentioned that the young scientist used works by world famous paleontologists including Deshayes G.P. (Deshayes, 1866), Nyst P.H. (Nyst, 1865), Wood S.V. (Wood, 1871), Michelin H. (Michelin, 1844), Koenen A. (Koenen, 1894). Later more prominent corypheuses of paleontology mistakenly considered the rocks with this fauna to be from the Oligocene period. Only half a century later was the Upper-Olegocene Epoch of the rocks finally proved (Sokolov, 1894).

But let us leave the territory of Oleksandriyskiy powiet and return with Domger to the routes in Verhnodniprovskiy powiet, where there is also a lot of interest. Travelling from the head of the river Omelnyk river within Popelnastivska volost, Domger noticed the outcrops of crystalline rocks dominating over the river valley, especially significant in Myhailivka village. He wrote: "Here mostly occur pink, partly white and gray granites, large- or average granular; in Popelnaste village they change to white gneissic types..." He notices red garnet in the granites and for the first time he finds syenite alkaline rocks in the ravine.

Contemporary mapping in the area of Popelnaste has found plagiogranites and migmatites of Saksahanskiy complex of Middle Archean Eon, which were significantly metasomatically altered: albitic, greisens and epidotic. Therefore, it was not accidental that Domger noticed them. A significant achievement of his travels along the Omelnyk was the discovery of marine deposits of Middle and Upper series of Paleogene, which was proven by the contemporary geological survey. In the area of Luhivka village, under the alluvium of the river, there were found rocks of Mezhuhriska, Obuhivska, Kyivska and Buchatska series of the Paleogene Epoch (Fig. 6). Domger also considered the sands of the Poltavaska suite of Neogene system in Sokolovka village, to be of Paleogene Epoch, which is easily explained by the absence of fossil fauna.

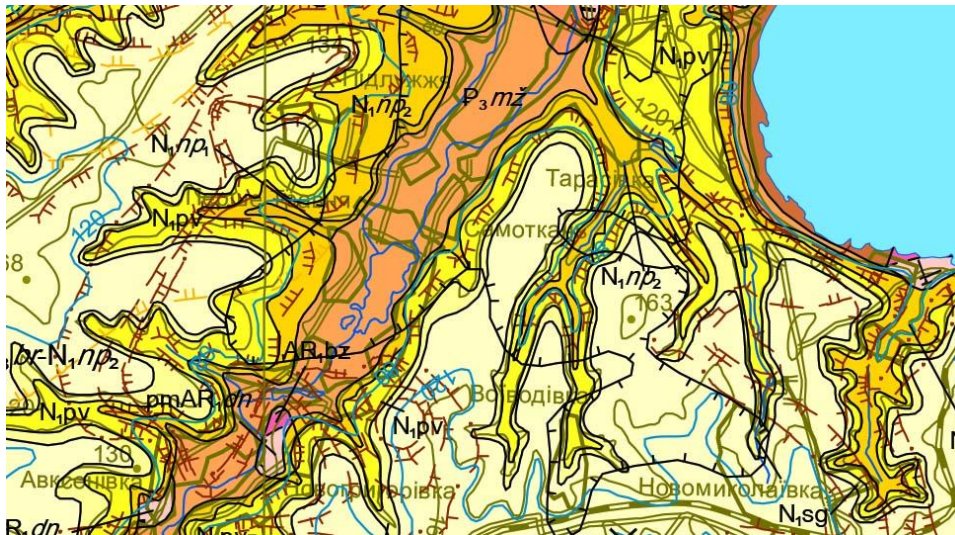


Fig. 6. Fragment of a geological map of Quaternary deposits

In the area of what is nowadays Holodivka village, near the place where the Vysoka ravine falls into the Hludova ravine, according to V Domger: "All the ground of the ravine is covered with small-granular sandstones..." A little further he writes: going up the Voronovka ravine, which leads to the Voronovka village, crossing the Strash-

na ravine there could be seen an outcrop of green-gray Paleogene sand, its gigantic boulders are randomly scattered along the slope of the Strashna ravine; above this sandstone, there are white small granular quicksands, overlapped by yellow clay" (Domger, 1884).

The boulders of quartzitic sandstones nowadays can be seen in the Taromske village. They belong to the Novopetryvska suite of Neogene sys-

tem. They were formed due to the processes of lithification and silicification of quartzitic sands of different age and origin (Fig. 7).



Fig. 7. Quartzite sandstones of sands of Novopetivska suite of Neogene Epoch

Similar boulders were used in constructing the "Kamyana mohyla" near the Terpinia village in Zaporizhia Oblast (Fig. 8). The boulders on the slopes of the Molochna were scattered just the same as in the Strashna ravine, but they were fated to become the natural material used by the members of ancient tribes in building their own "Stonehenge".

Farther in his journey along the Omelnyk from Lyhivka to the Dnieper, Domger found mostly outcrops of granites and single outcrops of white,

yellow and green sands, overlapped usually by brown clays and gypsum. The latter was the so-called thickness of mottled clays, which was formed during the late Miocene Epoch and early Pleocene Epoch, and was so saturated with gypsum concretions, which was the source of its extraction. V Domger wrote: "on the top of the Hostra ravine, on the land of Dniprovo-Kamianka village, gypsum is excavated."



Fig. 8. Quartzite sandstones in the "Kamyana Mohyla" reserve

Domger began his route along the Domotkan river from its mouth in Pushkarovka village, where he found an outcrop of gray gneissic granite, overlapped by a thick layer of sedimentary rocks, including the abovementioned yellow clayey sands with fractions of small-granular sandstone, which he considered to be of Upper-Eocene (Manyuk, V. 94

2003). Domger often mentions the so-called "pea or bean" ore in the above mentioned section. Sandy-clayey oolites of manganese and oxides are typical for Neogene-Quaternary layers of the Ukrainian shield and the Dnieper-Donetsk depression, but they are not numerous and the conjunctions of dendrites, oolites and their accumulation and the name

“pea or bean” is rather conditional. On an industrial scale, oolite and iron-manganese ores are found in the Prychornomie and the Kerch Peninsula (Fig. 9). Back to Domger’s notes, we find: “Below the mouth of the Chaplynka river (the largest right arbitrary of the Domotkan), on the right slope of the river, at a distance no bigger than one versta (1066,8 m) from Kovbasy, there is pretty large outcrop of granite in the yard of villager Tereshenko. This granite is gneissic and at some places becomes non-micaceous type (aplite)” (Domger, 1884). In the valley of the Samotkan river and its tributaries, unlike the places mentioned above, Domger’s studies were conducted not for mapping, but for the construction of the Katerynynska railway in 1881. According to Domger, in the places where the Samotkan flowed into the Dnieper: “near the

sawmill, stone was crushed for constructing the Railway Bridge in Katerynoslav (from the caissons of this bridge Domger put together his unique collection of fossil fauna from the deposits of the old Paleobasin, which was later termed the Mandrykivske Upper-Eocene sea). (Manyuk, 2002, 2007). In its content, it is gneiss and average-granular granites with veins of aplite leucocratic granites and pegmatites. These rocks turned out to be unfit for construction of the bridge and according to Domger all necessary material for the bridge piers and the base of the bridge was extracted from stone mines in Hlynske village (Domotkan). The remains of the flooded quarry can be seen even today on the bank of the Dnieper 1.2 km north-east from Domotkan village (Fig.10).



Fig. 9. Oolitic iron ore from the Kerch Peninsula

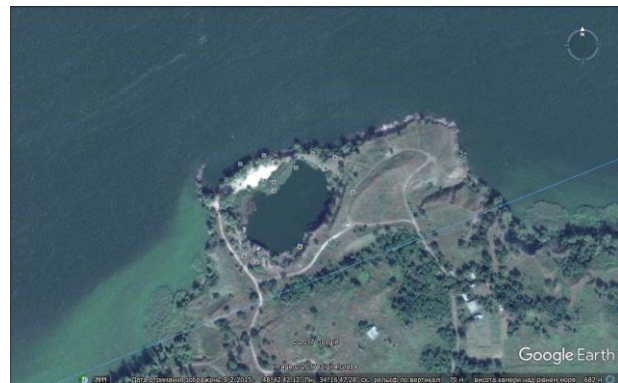


Fig. 10. Flooded Domotkan quarry, where "the stone was crushed" for constructing the Katerynynska Railroad

Domger made an interesting observation about the structural peculiarities of the gullies in the area. One part of the gullies is characterized by deep cutting, steep slopes and high activity, whereas the other is characterized by flatness, flat slopes; this indicates the different neotectonical positions of the geological megablocks on which the gullies developed. In the first case, the territory becomes affected by a local elevation, which intensifies physical processes, and in the second case, on con-

trary, the territory becomes affected by lowering and elevation of the basis of the erosion, which was the level of the Dnieper; this correspondingly stopped the lowering of the gullies and caused its gradual smoothing. In the valley of the Samotkan river, V Domger found outcrops of granites only in the following places: in the Soldatski Hutory (Hlyniana ravine) and in the Borokivka (Kamianysta ravine) (Fig. 11).



Fig. 11. Outcrops of migmatite plagiogranite in the Dnipropetrovsk Archean Complex

Nonetheless, the further description clearly states that there were other outcrops, they were insignificant, like for example, gneissic granites in Nesterovka village, which apart from crystalline rocks, has outcrops of Poltavski sands, which were the raw material for the brickworks which belonged according to Domger to the owner of the village. V Domger also noticed numerous outcrops of gypsum, which he called selenite (in fact, selenites are fibrous gypsum which are absent in the area). He writes: “The largest deposits of gypsum are, no doubt, in the riverhead of the Samotkan, in Vilni Hutory village, where the alabaster is obtained for fairs in the Katerynoslav and Kherson governorates during winter. The villagers told me that they distinguish three types: upper reddish, average white, or better to say colourless, and pure, the lowest – yellow”. (Domger, 1884). Nowadays the quarries of the Malyshevske titanium ores deposit expose over a large area Pleocene-Miocene dark-grey and

dark-brown clays with a high number of gypsum concretions, but the gypsum is not in any way used in the industry (Fig.12).

An important discovery of Domger was the white small granular friable sands with boulders of sandstones in the Voyevodska ravine, in the ravine near Hutora Berezovskoho and a layer of white sands and the millstones discovered by M P Barbotde-Marni in some other places in the valley of the Samotkan river. In spite of the absence of fossil fauna, Domger’s discovery was only a presumption, but it was proven by further geological studies, and the sands of the Novopetrykivska formation (previously known as “Poltavski”) along with the abovementioned sands of Sarmatian level contain deposits of ore minerals of the world’s largest titanium deposit (Manyuk, 2002, 2007, 2009, 2012).



Fig. 12. Pliocene mottled clay with gypsum concretions in the Samotkan quarry

Conclusions. The prodigious work performed by the prominent researcher of the geology of our region, Valerian Domger, his outstanding discoveries which placed him ahead of his time, formed the basis for the dramatic economic and cultural growth of the region, turning it into one of the main mining and industrial centers of Europe.

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