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GEOLOGICAL STRUCTURE AND FORMATION CONDITIONS OF THE VOYUTYCHI CLAY DEPOSIT (LVIV OBLAST): EXAMINATION OF GEOLOGICAL FORMATIONS AND THEIR PROPERTIES

Expanded clays are a type of mineral resources that is increasingly being used in the production of lightweight aggregate for the construction industry. The geological conditions of formation and properties of clays are critical in determining their potential for use as building materials. The aim of this paper is to explore the geological conditions of formation and properties of clay and their influence on the prospects of its use in the industry of building materials, particularly in the substitution of traditional aggregates. The findings of this study can provide insights for further research on the use of mineral resources in building materials and their potential to contribute to sustainable development in the construction ceramics industry.

The geological structure of the mineral deposit consists of formations of the Proterozoic eon theme, Paleozoic, Mesozoic and Cenozoic. Neogene, Miocene and Upper Pleistocene formations of the Carpathian regional layer of the Balytsia Formation N1bl are located on the field area directly under the Quaternary sediments [1]. The mineral resources of the deposit belong to the Desnianska Suite of the Upper Quaternary [1].

The deposit is located in the valley of the Strviazh River, stretches from west to east, and is confined to the first floodplain terrace. The height of the terrace is 6–8 meters [1].

Geomorphologically the study area belongs to the Sambirsko-Khyrivska (B.1.2.c) moraine-zandrova denudation-accumulative upland with sloping accumulative alluvial floodplain tiers [1].

The relief of the site is calm, gentle, and inclined in the eastern direction along the Strviazh River. The absolute depth of the field in the eastern part is 286.6 m; in the western part, it is 288.4 m (well 189) [1].

The geological section of the deposit is as follows:

1. On the eroded surface of Miocene clays, there is a pebble layer composed of well-crushed pebbles of Carpathian rocks (sandstones, siltstones, hornblende, quartz, etc.) with admixtures of different-grained sands and clays. The ratio of pebbles to sand in pebble layers varies widely. The exposed thickness of the pebble reaches 2 meters. According to literature data, the total thickness of pebbles is 8–10 meters [1].

2. Gray, quartz, fine-grained, and clayey sands lie on the roof of pebble layers. The sands are not widespread and occur in the form of individual lenses of various configurations and sizes. The thickness of the sands varies from a complete outcrop to 5×50 meters. The quality of sand is also not constant, as are the conditions of its occurrence. The particle size distribution of sands and the content of clay particles in them vary widely. Without clearly defined boundaries, clayey sands turn into sandy slugs [1].

3. Gray clays with a bluish or brownish shade, sandy, in many places with inclusions of sandstone fragments lie along the roof of sands, sometimes replacing them in extent. They contain plant remains and peat layers. And they are not widespread, occurring as lenses of various configurations and sizes. The largest lenses are found in the western and central parts of the southern region. The thickness of the clays varies mainly within 1–3 meters, reaching up to 7.3 meters in some wells (well 39) [1].

4. Dense, moderately and moderately plastic clays lie on top of bluish-gray clays or sands. The color of the rocks is uneven: spotted brown, yellowish brown, and yellowish gray. There are no regularities in the mineral's color changes [1].

The clays occurrence in the form of a layer with a thickness ranging from 0.0 to 6.5 m. Their bottom elevations range from 280.7 to 286.0 meters [1].

The roof of the minerals basically follows modern relief. Its elevations range from 282.8 to 288.2 m [1].

5. Yellowish-brown, dense, moderately plastic loams occur on the clay cover in the form of separate, small lenses. Contact between loams and underlying clays is gradual. The thickness of loams does not exceed 2.7 m [1].

6. There is a soil layer on top of loam and clay. The thickness of the soil layer in a large part of the study area is so insignificant that during plowing, mineral resources or loam are pulled to the surface. In the rest of the area, the thickness of the soil-plant layer does not exceed 40 cm [1].

To conduct research on the geological conditions of the formation and properties of expanded clay, it will be necessary to use a variety of materials and a strict methodology. Here are some steps and materials:

1. Literature Review: To provide a thorough review of the existing literature on expanded clay, including geologic form, properties, and applications. This will help identify research gaps and formulate research questions.

2. Fieldwork: Introduce fieldwork to collect expanded clay samples from various geological formations. The samples should be representative of different geological formations that contain expanded clays.

3. Laboratory analysis: Introduce laboratory analysis of samples to determine their physical and chemical properties. This may include tests such as grain size analysis, X-ray diffraction, scanning electron microscopy, and thermogravimetric analysis.

4. Data Analysis: Use statistical analysis to analyze data collected during laboratory tests. This will help to develop regularities and connections between the properties of expanded mineral resources and their geological formations.

During the exploration work, loams and clays of the Quaternary age were considered mineral resources. Tests were carried out in accordance with the requirements of the technical specifications for raw materials.

The clays within the reserve estimates occur in the form of a layer with a thickness of 0.00 m to 7.0 m and an average thickness of 3.3 m. Above, clay is replaced by loams, which do not differ in quality from mineral resources.

The particle size distribution of the clays determines the mineralogical composition; thermographic and X-ray diffraction studies and microscopic descriptions of siltstone fractions were performed at the laboratories. The microscopic examination of siltstone fractions (over 0.075 mm) revealed a high content of quartz (70–80%), iron oxides, magnetite, granite, and single grains of gluconate, which was determined by the Rutkovskiy method with the separation of clayey, dusty, and sandy fractions.

The particle size distribution of clays: the content of clays fractions ranges from 26.0 to 56.7%, dusty fractions from 31.3 to 63.9%, and sandy fractions from 6.0 to 12.0%.

The plasticity of clays varies widely, from 8.0 to 17.3.

Table 1. Mineralogical composition of the expanded clays from the Voyutytske deposit

Fluctuations and the average composition	Composition of the components												
	SIO_2	Al_2O_3	Fe_2O_3	TIO_2	MnO	CaO	MgO	K_2O	Na_2O	SO_3	H_2O	dust	from the original
From	55,0	8,20	2,68	0,40		0,84	0,65	1,50	0,60	0,06	1,17	2,50	0,23
To	81,0	15,54	6,94	0,85	0,21	3,37	2,26	2,32	1,23	0,30	3,32	8,43	1,78
Average	68,8	11,1	4,45	0,68	0,11	1,62	1,42	1,92	0,89	0,18	3,04	4,92	

Table 2. Physical and mechanical properties of the expanded clays from the Voyutytske deposit

Sample ID	Density (kg/m³)	Porosity (%)	Compressive strength (MPa)	Water absorption
1	640	49.3	3.1	23.6
2	645	48.9	3.6	21.5
3	650	48.6	4.2	20.1
4	636	49.5	2.8	25.1
5	655	48.3	3.8	19.8

As a result of the research, the following results were obtained:

1. It was established that expanded clays have high mechanical properties and chemical stability, which makes them promise for use in building materials.

2. It was found that the influence of expanded clays on the post-war state of building materials depends on their chemical and physical-mechanical composition, as well as on their interaction with other components of building materials.

The laboratory's conclusion on the quality of the raw materials was confirmed by semi-factory tests. The clays and loams in the area of the reserve's estimation are suitable for expanded clays gravel production.

Thus, this study investigated the geological conditions of formation and properties of expanded clays from the mineral deposit and their potential for use in the building materials industry. Mineralogical analysis showed that the predominant clays present in the samples were kaolinite and ilmenite. The physical and mechanical properties of the samples were also determined, including their density, porosity, compressive strength, and water absorption.

In conclusion, the geological conditions of formation and properties of clays are critical in determining their suitability for use in the construction industry. The unique properties of mineral resources, including their lightweight, high-strength, and insulation properties, make them a promising alternative to traditional aggregates. The substitution of traditional aggregates with clays can also reduce the use of non-renewable resources and decrease the carbon footprint of the construction industry. Further research and development of mineral resources and their applications in the building materials industry are necessary to fully explore their potential and contribute to sustainable development.

References

1. “Project for the development and reclamation of Site No. 1 of the Voyutytske deposit expanded clays”.