GEOLOGY, MINERALOGY AND SOIL SCIENCE

Ishkov Valerii Valeriiovych
Candidate of Geological and Mineralogical Sciences, Associate Professor, Department of Geology and Mineral Prospecting, Dnipro University of Technology, Ukraine
Senior Research Fellow, Laboratory of Studies of Structural Changes Rocks
M.S. Polyakov Institute of Geotechnical Mechanics of the NAS of Ukraine, Ukraine

Kozii Yevhen Serhiiovych
Candidate of Geological Sciences,
Director of Educational and Scientific Center for Training of Foreign Citizens
Dnipro University of Technology, Ukraine

Dreshpak Oleksandr Stanislavovych
Candidate of Technical Sciences (Ph.D), Associate Professor,
Department of Technological Engineering of Materials Processing
Dnipro University of Technology, Ukraine

Berezniak Olena Oleksandrivna
Head of the Laboratory, Department of Technological Engineering of Materials Processing
Dnipro University of Technology, Ukraine

Chechel Pavlo Olehovych
Senior Laboratory Assistant, Department of Technological Engineering of Materials
Dnipro University of Technology, Ukraine

Pashchenko Pavlo Serhiiovych
Candidate of Geological Sciences, Senior Research Fellow,
Laboratory of Studies of Structural Changes Rocks
M.S. Polyakov Institute of Geotechnical Mechanics of the NAS of Ukraine, Ukraine

THE MAIN RESULTS OF MINERALOGICAL AND PETROGRAPHIC STUDIES OF LIMESTONES FROM NOVOSELYTSKE DEPOSIT (UKRAINE)

Abstract. *The paper presents the results of mineralogical and petrographic studies of limestones from Novoselytske deposit (Ukraine). The main attention is paid to the mineral composition and structural features, which determine the geological and commercial type of this mineral, and, consequently, the most rational area of its application. At different scale levels, the features and causes of recrystallization and appearance of zoning have been established.*
Keywords: *limestone, calcite, recrystallization, zoning.*

Introduction. Administratively, Novoselytske deposit is located on the territory of Uzhhorod Raion of Zakarpattia Oblast, on the north-western outskirts of village Novoselytsia.

On a regional scale, in geological and structural terms, the deposit is directly located in the junction zone of two large structural elements of different ages: Neogene Intracarpathian volcanic belt and Mesozoic-Paleogene Outer (Flysch). Locally, it is confined to a peculiar tectonic element of the Transcarpathian deep-seated fault – to the flysch complex of the Peninska structural-facial zone (or Cliff zone).

Currently in Ukraine there is a shortage of lime raw materials, which are in demand in many industries and agriculture. The relevance of the performed research is due to the urgent need to strengthen and expand the mineral resource base necessary to ensure Ukraine's sustainable development.

Purpose: identification of mineralogical and petrographic features of limestones from Novoselytske deposit in order to determine the areas of their most effective use.

Materials and Methods. Samples from Novoselytske deposit (40 pieces) were studied using a complex of mineralogical (visual observation of diagnostic signs and features (using binocular microscope MBS-9), determination of hardness on the Mohs scale (using a set of reference hardness pencils), microchemical tests (checking the reaction with a solution of 10% hydrochloric acid) and petrographic methods (examination of petrographic thin sections in transmitted ordinary and polarized light using a binocular polarizing microscope POLAM R-312). At least two thin sections were made from each sample, made in mutually perpendicular planes. Therefore, 97 petrographic sections were examined.

Findings and Discussion. Calcium carbonate (calcite) is the main rock-forming mineral in limestone samples (content in samples amounts 96 ± 4%). At the same time, there is an insignificant impregnation of clay minerals and iron hydroxides.

On the surfaces of a new-made shear of limestone samples, its microporous nature was clearly observed. At the macro level, the ubiquitous presence of areas that differ in color and intensity of color has been established. At the same time, recrystallization areas were clearly visible (visually stand out with a lighter shade, up to white). These areas, as a rule, form linear elongated zones (resemble veins) forming subparallel systems. Authors assume that the appearance of white areas is caused by local recrystallization of limestones, which causes "purification" of calcite crystals from mechanical impurities of clay particles and iron hydroxides. A feature of the general spatial distribution of these sections (zones) is their linear-periodic nature (fig. 1). Similar zones of local recrystallization of mineral matter and their influence on the migration of individual chemical elements in relation to coal-bearing strata were previously discussed in [1 - 21].

In some cases, the process of recrystallization leads to the appearance of zoning in the color of individual crystals (fig. 2, fig. 3). On the walls of limestone micropores, both individual calcite crystals and their aggregates were found (fig. 4).

Fig. 1. **Recrystallization areas**

Fig. 2. **Zoned calcite crystals**

Fig. 3. **Zoned calcite crystals**

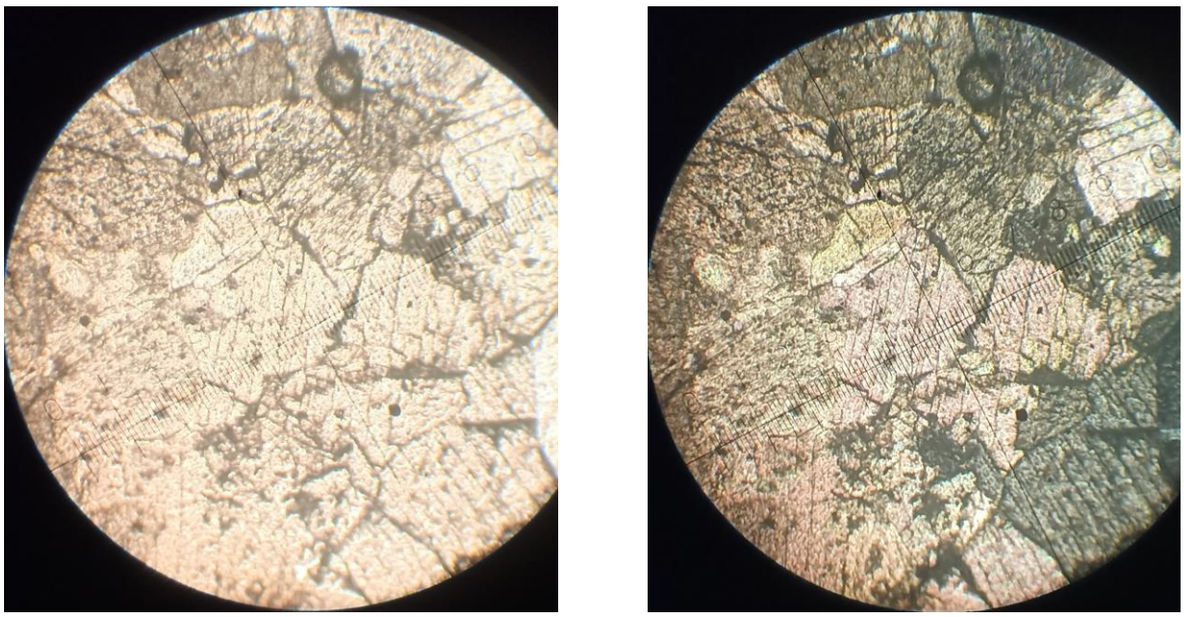
Fig. 4. **Calcite crystals on the surface of a limestone micropore**

When looking at the zoning in the color of individual calcite crystals caused by the presence of mechanical impurities, two options are observed. In the first case, zoning generally corresponds to the distribution of impurities in accordance with the features of its structure (fig. 3). In this case, we observe the classical variant of the occurrence of zoning due to changes in the growth conditions of the calcite crystal.

In the second case, the zoning in the color of the crystal (hence, the distribution of mechanical impurities) is absolutely not related to the anatomy of its internal structure (edge growth pyramids, edge growth surfaces and vertex growth lines). Moreover, it can be traced linearly in the neighboring grain (fig. 2). That is, its causes are not related to variations in the parameters that control the crystallization of calcite in limestones from Novoselytske deposit. It is logical to assume that the processes leading to the emergence of such zoning have a superimposed, epigenetic character. Similar phenomena were recorded in the works [22 - 24].

Authors believe that the emergence of the second variant of zoning is directly related to the phenomena of self-regulation of a crystalline substance and a decrease in the level of stresses (shift of phase equilibria, formation of incoherent boundaries, various methods of plastic and brittle relaxation) in the process of recrystallization of already formed crystalline individuals. Such zoning should be considered as "recrystallization zoning" [25 - 26].

In the process of petrographic studies of thin sections made from limestone samples from Novoselytske deposit no organic remains or their fragments were found. At the same time, a number of indicators were established [27 - 41], showing the presence of local recrystallization of the mineral matter under the influence of brittle (fig. 5) and elastic-plastic deformation (fig. 6). In the first case (fig. 5), the calcite grain was crushed into several parts because of brittle deformations. In the second (fig. 6) – at the cross hairs there was intensely microblock and fractured calcite crystal with several mechanical (deformation) twins, or glide (shear) twins, formed as a result of plastic deformation under the influence of directed pressure and emerged after the formation of the crystal (secondary twins).

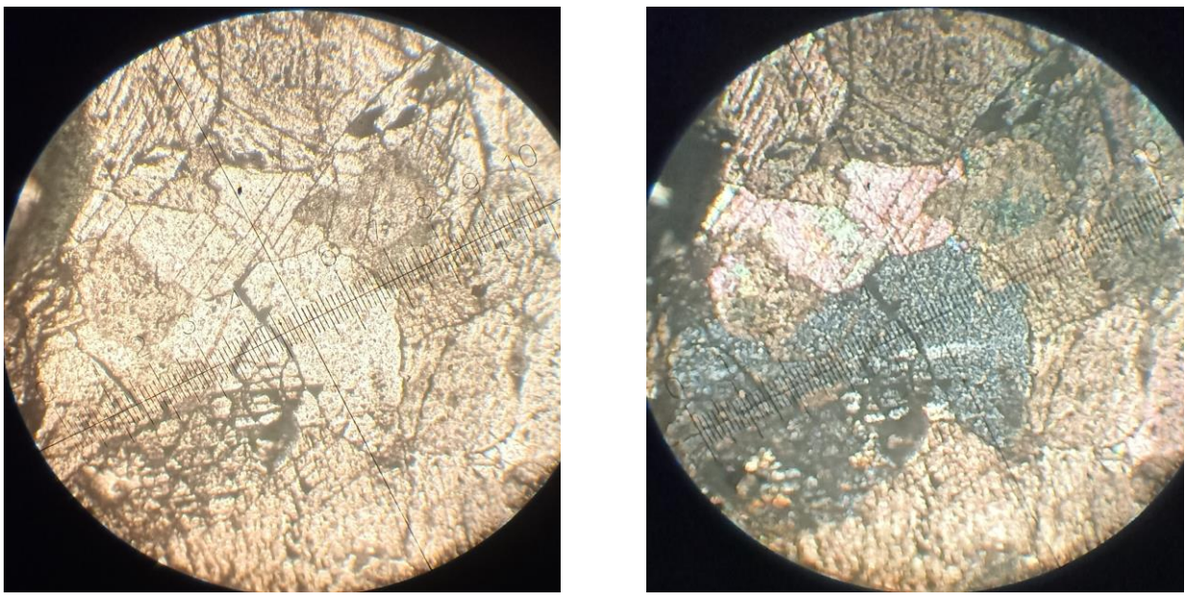


a b

Fig. 5. **At the cross hairs there is a grain of calcite, crushed into several parts; a – ordinary transmitted light, b – polarized transmitted light. Magnification x60**

From the presented factual material, it follows that the recrystallization zones of each system are separated from each other by approximately equal distances, in other words, these regions are separated from each other at a distance that is a multiple of a certain recurrence period. This phenomenon was previously noted in [42 - 50]. It must be assumed that the identified areas of recrystallization owe their

origin to pulsating stresses that occur during tectonic dislocations. These stresses, acting for a long time in one direction, cause the appearance of longitudinal-harmonic vibrations of the particles of the rock mass and periodic superposition of conjugated compression-tension regions. This circumstance causes vigorous filtration of intergranular and hygroscopic water from the rock itself, calcium carbonate salts, carbon dioxide and subsequent deposition of calcite crystals on the walls of micropores.



a b

Fig. 6. **At the cross hairs there is intensely microblock and fractured calcite crystal with several twins; a – ordinary transmitted light, b – polarized transmitted light. Magnification x60**

Conclusions:

1. Limestones from Novoselytske deposit are marmorized chemogenic limestone.

2. Clay minerals and iron hydroxides are present in the form of a small amount of mechanical impurities both in micropore space (can be partially removed by washing during crushing), and as impregnations in calcite grains.

3. Possible applications for this type of marmorized limestone: as a limestone flux in the metallurgical industry, in agricultural production in the form of lime flour

in poultry farming and in the production of organic fertilizers, in the construction industry as the main component of the charge for the production of cement and lime, production of finishing materials, as crushed stone – concrete filler, for the construction of highway foundations, facade material and raw material for the manufacture of design elements for placements.

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