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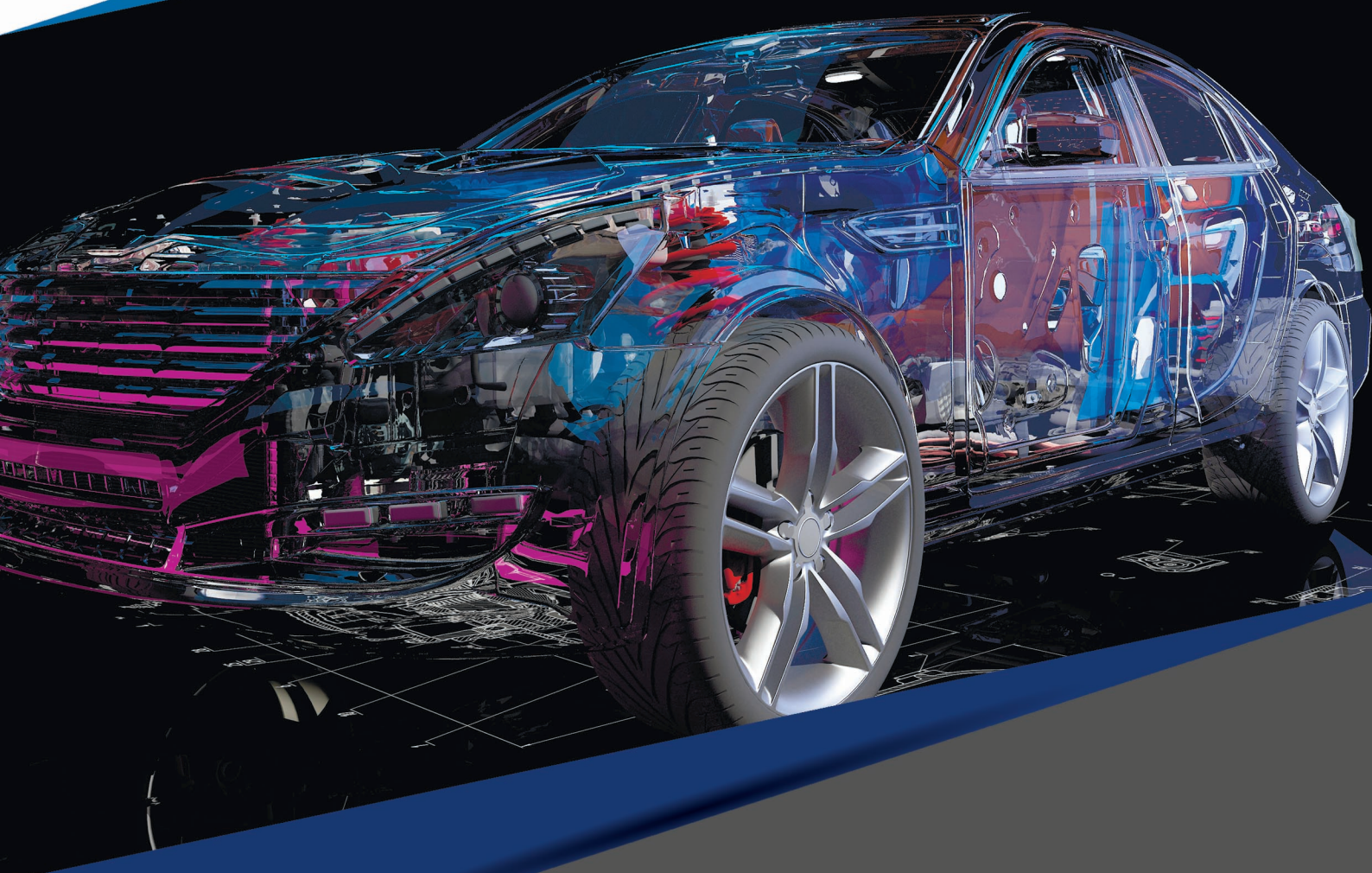

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Authors - Demchyna B., Vozniuk L., Surmai M., Hladyshev D., Babyak V., Kovalchuk V., Onyshchenko A., Fedorenko O., Pentsak A., Petrenko O., Єсакова С.В., Вовк Л., Гладишев Д.Г., Гладишев Г.М., Бродський М.О., Вознюк Л.І., Зятюк Ю., Борисюк О., Фурсович М., Попович П.,Коверніченко Л.М., Смірнова О.В., Borutska Y., Pankaj S., Getman I., Holovach T., Muzyka S., Starokadomsky D., Reshetnyk M., Sigareva N., Terebilenko A., Shulga S., Trus I., Halysh V., Nikolaichuk A., Gomelya M., Krysenko T., Рахымбеков А.Ж., Kyivska K., Tsiutsiura S., Tsiutsiura M., Terentyev O., Zaykov V., Mescheryakov V., Zhuravlov Y., Gnatovska A., Бойко Н., Кононихін О., Філь Н., Чорний Б., Мірошник В., Кривобока Г., Самсонов В., Сільвестров А., Спінул Л., Чикина Н.А., Антонова И.В., Ярош С.П., Савельєв А.М., Запара Д.М., Новіченко С.В., Третяк В.Ф., Denysiuk S., Derevianko D., Romanchenko O., Dobrolyubova M., Kozyr O., Statsenko O., Shevchenko K., Бурлак Г., Вілінська Л., Antiushko D., Shapovalova N., Fursik O., Kuzmyk Y., Svyatnenko R., Marynin A., Strashynskyi I., Pasichniy V., Kyshenko V., Romashchuk O., Pankov D., Kyshenko V., Ladanyuk A., Kryshchenko D., Biletskyi M., Peshuk L., Kondratiuk N., Polyvanov Y., Kozhemyaka O., Verkhivker Y., Myroshnichenko E., Pavlenko S., Dotsenko N.,Гачак Ю.Р., Гутий Б.В., Дзюба Н.А., Дубина А.А., Дубина А.А., Кондратюк Н.В., Степанова Т.М., Польщикова Н., Василенко А., Сташенко М., Танивердиев А., Уманенко И., Savenko V., Zuravskiy O., Vysotska L., Pobeda S., Kleshchenko O., Лемешев М., Черепаха Д., Черепаха А., Стаднийчук М., Королевская С., Savenko V., Nesterenko I., Shatrova I., Demydova O., Klyueyva V., Саньков П.М., Журбенко В.М., Сєлюков О.В., Лєнков Є.С., Зінчик А.Г., Пашков О.С., Бондаренко Т.В., Hlushkova D., Kalinin V., Stepanyuk A., Hnatyuk A., Serzhenko I., Roik T., Gavrysh O., Gavrysh J., Senkus V., Kolomiiets A., Behen P., Kotovskii O., Nechiporenko V., Salo V., Litovchenko P., Яглінський В., Гутиря С., Matiko F., Matiko H., Krykh H., Крупка Я., Wyszniewski D., Кононов С., Білик О., Олійник В., Dolzhenko N., Артеменко О., Тимошенко А., Сагановская Л., Данилко О., Зубенко Д.Ю., Петренко А.Н., Халиль В.В.

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SECTION 2. CHEMICAL TECHNOLOGY

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2.1 Peculiarities of the flysch formation of the Ukrainian Carpathians and their influence on the formation of fresh waters of the basin

The Cretaceous-Paleogene Carpathian flysch (flysch formation) is a polyfacial formation, both in sections and in areas (Hurzhyi D.V. (1981); Afanasieva I. M. (1979)). The main differences between its constituent parts are the rock types, their rhythmicity, coloring, calcareous, siliceous, mica, organic matter enrichment, siderite, textural features, presence of fossil organisms, marker horizons, etc. (Fig. 1).

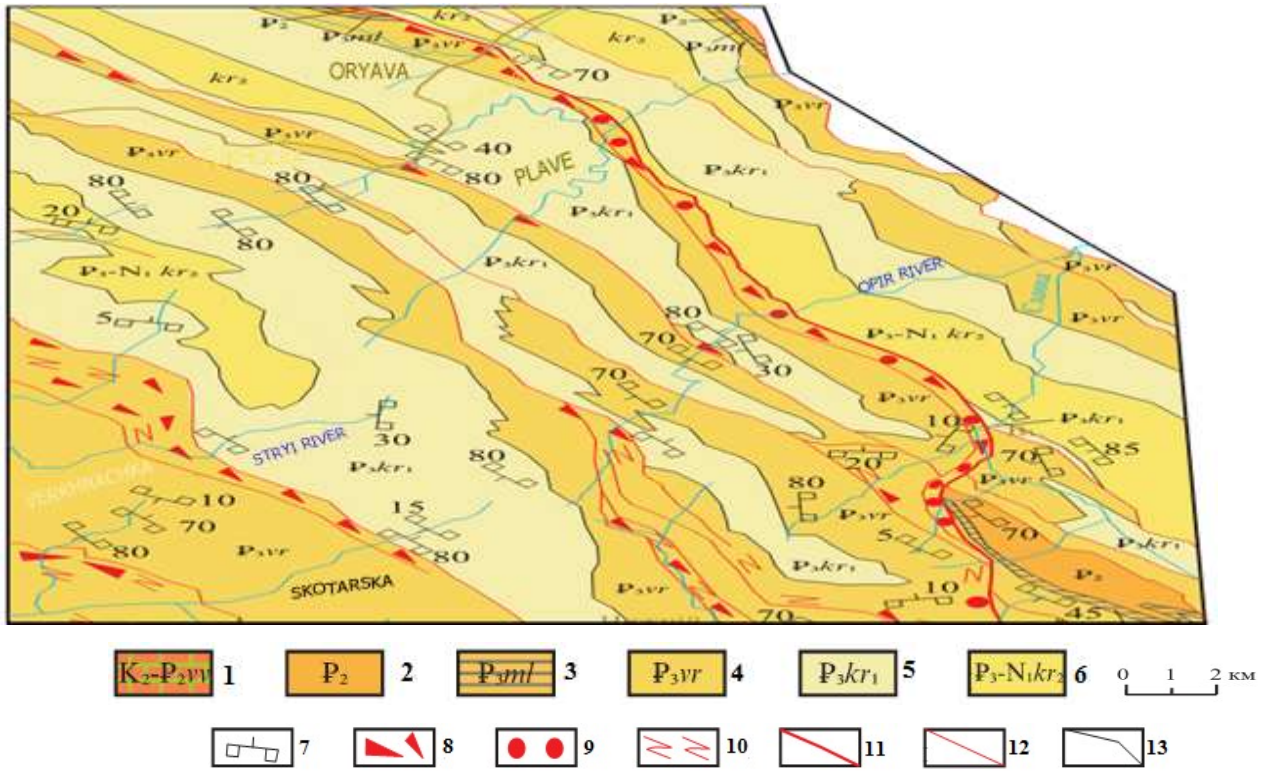

Fig. 1. Fragment of the geological map of the Stryi River basin (compiled from (Lozyniak P. Yu., Petrashkevych M. I. (2007)))

1 - upper cretaceous-eocene variegated marl of the Hungarian type; 2 - eocene flysch; 3 - menilite light; 4 - verek (transitional) light; 5 - lower precocene subformation (toustorhythmic sandy flush) 6 - middle precocene subformation (middle-rhythmic gray flysh) 7 - elements of bedding of rocks (rectangles show the lower surface of layers) 8 - tectonic breccias, melange of fragile type 9 - tectonic melange of plastic type; 10 - zones of intensive shallow folding; 11 - major faults, cover boundaries; 12 - secondary faults; 13 - geological boundaries of straton.

In the territory of the Stryi River basin, the cretaceous deposits of the flysch formation are established within the Skyba and Boryslav-Pokuttya nappes, while not found in the outcrops within the Krosno cover.

Lower cretaceous sediments are found locally, represented by the Spas, Holovanivsk, and Ilemkivsk formations of the upper barrem –low albumin, in outcrops both in the Stryi River basin and in adjacent territories in the vicinity of Sambir, and are exposed in wells Luhy-1 and Shevchenkovo-1. The Spas horizon (K1sp) flysch sediments are represented by black siliceous mudstones interbedded with dark gray siliceous siltstones and thinly laminated sandstones. Often there are layers of flints in the section. Stratigraphically, above and according to the Spas strata, there are deposits of the Holovanivsk formation (K1hl) cryptocrystalline limestones with thin interlayers of variegated rocks. In the northeastern direction, they gradually increase the content of variegated clay rocks (M.P. Gabinet, J.A. Kulchytskyi, O.I. Matkovskyi et al (1976)); (1977)).

The upper cretaceous deposits are spread within the Skyba and Boryslav-Pokuttya nappes and are represented by the Stryi formation (Santon Dunaya) of gray and greenish-gray flysch in which three subformations are distinguished: lower Stryi (K2sr1), middle Stryi (K2sr2) and upper Stryi (K2-P1sr3). The lower and upper sub formations of the Stryi horizon are composed mainly of gray limestone fine- and medium-rhythmic flysch with almost equal contents of silt-sand and clay components or with the dominance of clay components. The marl and limestone layers (slightly more abundant in the lower one) are present in these subformations. The middle Stryi subformation is characterized by a sharp predominance of sandstones or coarse-rhythmic flysch.

The paleogene flysch is represented by paleocene, eocene, and oligocene sediments. The upper paleocene sediments are represented by the Yamnensk formation (P1jm), composed of massive and tovstosharuvatymi sandstones, the thickness of which varies from a few meters to 200-250 m. At the base of the Yamnensk horizon lies the Yaremche horizon, a thin green or variegated no limestone flysch, not more than 90 m thick. The lower ocene fine- to medium-rhythmic clayey siliceous flysh of

the Manyava horizon (P1mn) overlaps the Yamnensk sediments and is represented by the paleogene, eocene and oligocene sediments. The upper paleocene sediments are represented by the Yamnesk formation (P1jm) composed of massive and toasty sandstones whose thickness varies from a few meters to 200-250 m. At the base of the Yamnensk horizon lies the Yaremche horizon, a thin green or of variegated not limestone flysch, not more than 90 m thick. The lower ocene fine- to medium-rhythmic clayey siliceous flysh of the Manyava horizon (P1mn) overlaps the Yamnensk horizon. In the Beregovo Skyba, where the Yamnensk sandstones liquefy, the same-type Yaremche and Maniava sediments merge into an undivided uppper paleocene-lower eocene (P2) strata.

The Middle Eocene is represented by the sediments of the Vyhoda horizon (P2vp), which is usually composed of massive varied-grained sandstones. The upper eocene is represented by green mudstones and thin-rhythmic flysch of the Bystrytsya horizon(P2bt). In the northwestern part of the Stryi River basin, south of Boryslav, the Vyhoda sandstones are flushed and the entire Eocene is represented by an almost inseparable sequence of medium- and fine-rhythmic flysch, whereas in the south of the basin, in the Rozhanka River valley, not only the Vyhoda and Bystrytsya deposits are flyshed, but also the Yamnensk sandstones, which are distinguished by an inseparable complex of paleocene-eocene. Here, the same stratigraphic units are distinguished in the upper paleocene-eocene section as in the Skyba nappe within the Turka subpopulation of the Krosno nappe: the Yamnensk, Manyava, Vyhoda, and Bystrytsya horizons. However, the deposits of these stratigraphic units are characterized by an increase in the creaminess of rocks and thickness of sandstones, primarily for the Manyava and Bystrytsya horizons (M.P. Gabinet, J.A. Kulchytskyi, O.I. Matkovskyi et al (1976)); (1977)).

The oligocene in the Stryi River basin is represented by the menilite horizon (P3ml), which includes the following sublocations: lower P3ml1, middle (Lopyanka horizon P3lp), and upper P3ml3, as well as the Krosno horizon (P3kr), which is composed of three subhorizons: lower P3kr1, middle P3kr2, and upper P3kr3. The lower menilitic subhorizon stack is characterized by the presence of a subflint sequence

of variable thickness (from 1.5 to 60 m) at the base of the section. It is formed by alternating black, dark gray and brown, often very calcareous mudstones, siltstones, sandstones, and marls. Above it lies the main marker horizon, the lower precambrian, by which the boundary between the eocene and oligocene is conventionally drawn. The horizon is composed of black and brown cherts, siliceous mudstones, siltstones, sandstones, limestones, and marls, with tuff lenses in places. Above this horizon, the lower menilite horizon is composed mainly of fine-rhythmic flysch of the menilite facies, which gradually transitions to coarse-rhythmic interbedding (M.P. Gabinet, J.A. Kulchytskyi, O.I. Matkovskyi et al (1976)); (1977); Gabinet M.P. (1985)).

In the basement of the middle menilite sublayer (Lopyanka horizon), a horizon of striped limestones 0.25 to 4.0 m thick is located. It is composed of irregular alternation of gray and dark gray limestone argillites, siltstones and sandstones with separate layers of marls and siderites. The middle and upper subformations of the menilite world are separated by the upper siliceous horizon.

In the upper cretaceous section, black and dark gray stratified argillites are the most important, while the amount of sandstones and siltstones decreases upwards in the section.

The Krosno horizon makes up the upper part of the oligocene section in the Krosno nappe. The lower Krosno sub horizon is characterized by a coarse-rhythmic sandy fleece, the middle Krosno subhorizon by a moderately rhythmic uniform fleece, whereas the upper Krosno subhorizon is characterized by a fine-rhythmic clayey sequence.

In the Boryslav-Pokuttya nappe, pni-ligocene - early miocene dark gray mudstones with interlayers of the Polyanytsya horizon sandstones (P3-N1pl) lie on cretaceous and paleogene sediments with erosion. They are often based on conglomerates with pebbles and blocks of flysch rocks (M.P. Gabinet, J.A. Kulchytskyi, O.I. Matkovskyi et al (1976)); (1977)).

The Precarpathian troughs in the Stryi River basin are filled with neogene deposits of the molassic formation, which overlie the flysch formation in the Boryslav-Pokuttya and Sambir nappes. In the section of the molassic formation, the Vorotyshche

(upper eger-Karpaty) - N1vr, Stebnytsky - N1sb and Balychi - N1bc (otnang-Karpaty) horizons are distinguished. The Vorotyshche horizon is subdivided into three subformations: lower Vorotyshche (N1vr1), composed of gray clays with rare interlayers of sandstones, lenses of exotic conglomerates, layers and lenses of salts; middle Vorotyshche (Zahirya horizon) - N1vr2, which has an unstructured along the strike and is composed of sandy-clay deposits with lenses and packs of gravelites and conglomerates; the upper vortex (N1vr3), which is represented by a sequence of salt breccias and clays containing beds and lenses of rock and potassium salts with siltstones and sandstones.

The Stebnyky horizon (N1st) is composed of red and pink limestone clays and mudstones with interlayers of weakly cemented variagated multigrained sandstones, which transition into gravelites and microconglomerates with pebbles of exotic and flysch rocks. There are also dacite tuff checks in the world section. Lithologically similar to Stebnyky, the Balychi horizon(N1bc) has layers and bundles of weakly cemented fine-grained sandstones among the greenish-gray limestone clays. The section of the horizon is often enriched in coarse silty material of gravels and conglomerates with fluvial pebbles and jurassic limestones (M.P. Gabinet, J.A. Kulchytskyi, O.I. Matkovskyi et al (1976)); (1977)).

The quaternary deposits in the Stryi River basin are represented by several genetic types of sections: eluvial, aeolian, dealluvial, colluvial, proluvial, alluvial, often combined and different within the development areas of the flysch and molasse formation (Zamorii P. K. (1961)).

Thus, the eluvial quaternary deposits within the flysch formation are mainly represented by thin interlayers of zwitrilinear sandstone, crushed rock, and sandy gravel mixed with sand and loam. The thickness of eluvial deposits proper, developing on flysch rocks rarely exceeds 1.0 m. At the same time, eluvial deposits on saline molasse are represented by the so-called gypsum-clay cap - unstructured plastered clays, sandstone fragments and relics of other rocks, which are a kind of insoluble residue. Above the potassium deposits at the explored Hirne potassium salt deposit, the

thickness of the "cap" reaches 65-75 m. The gypsum-clay "cap" plays an important protective function for the penetration of fresh water into the saline deposits.

Aeolian deposits of loess-like loams are typical for watershed areas within the Precarpathian trough. The loess-like loams are light yellow, piled, macroporous, often carbonate with shrinkage of various shapes, 1-5 cm in size. In the middle part of the section, a horizon of dense sandy loams and loams of heterogeneous color, with a jasic-lens-like structure stands out.

Deluvial quaternary sediments are distributed mainly on the mountain slopes and are represented by sandy loams up to 5 m thick. Deluvial deposits, unlike eluvial ones, have no signs of direct connection with bedrock. According to the mechanical composition, clay and loam varieties with an admixture of rubble debris prevail among dealluvial sediments.

Colluvial quaternary deposits are represented by scree and rockfall formations of clumps, rubble, crushed stone, sand, and loam at the foot of steep slopes as a result of rolling and sliding down the slope (Zamorii P. K. (1961)).

Proluvial quaternary deposits are represented by debris-flow removal cones and other formations of temporary streams. The dimensions of the removal cones are insignificant (from 3x5 m to 15x20 m, rarely 50x100 m).

Extremely important from hydrogeological positions are alluvial quaternary deposits composed of boulders, pebbles, gravel and sand, which in the basin of the Stryi River are localized within the floodplain and floodplain terraces.

In conditions of natural cycle water evaporates from the surface of water areas and land, in the form of atmospheric precipitation, interacting with air, soils, rocks, biota, products of anthropogenic human activity, enters into chemical reactions, dissolves and leaches most components - from gases to minerals actively changing its original chemical composition.

Analysis of the regularities of formation of the chemical composition of natural waters shows that one of the most important factors in this process is the climate of the catchment area of the Stryi river. Stryi, namely the amount and chemical composition of atmospheric precipitation. These parameters directly depend on the vertical climatic

zoning of the Carpathian mountains, clearly correlated with the geomorphological parameters: from low to high elevations of the relief there is a natural decrease in temperature parameters and atmospheric pressure, increasing the amount of atmospheric precipitation. Average long-term values of precipitation clearly change in accordance with the geomorphological vertical zoning of the territory with gradients of changes in annual precipitation amounts with height, 80-90 mm for each 100 m of absolute altitude - from 650 mm at the mouth (239 m), 684 mm in . Stryi (296 m), 844 mm in Turka (557 m), 957 mm in Slavske (600 m) to more than 1200 mm in the mountainous part, at altitudes above 1000 m.

Therefore, taking into account the above, the main factors of formation of the chemical composition of natural waters are climatic conditions, amount and hydrochemical features of atmospheric precipitation. Due to infiltration of precipitation, presence of water-soluble minerals in soils and water-bearing sediments, interaction of oil and water phases within oil-producing areas the equilibrium chemical composition of natural waters is formed.

Conclusions

The geographical location of the Stryi river basin determines the peculiarities of landscapes, soil cover, flora and fauna of the territory. Tectonic position and features of the geological structure are determinative in the formation of geomorphological, orohydrographic, hydrological, geoecological and geochemical conditions, as well as natural-resource and economic potential of the territory. Economic use of resources of the territory leads to the anthropogenic transformation of the Stryi River basin, determines the main features of the processes of technogenesis and their impact on natural waters.