Formation conditions of the veinlet-impregnated mineralization in Paleozoic deposits of the Lviv Depression (the West of Ukraine)

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Because of tthe rise of demand for energy carriers worldwide, the usage of unconventional hydrocarbon (HC) raw materials, first of all such as HC gases of the gas-oil fields and "shale" gas of the black shale formations is a vital problem. One of such regions is the Lviv Paleozoic Depression included in the Volyn-Podillya petroliferous area (Dolenko *et al.* 1985). This is confirmed by the discoveries of the Velyki Mosty and Lokachy gas fields in the rocks of the Lower and the Middle Devonian. At the top of the section, in the Carboniferous coal-seams, the Mezhyrichchya gas-coal field is located and Silurian rocks, occuring stratigraphically below, are promising for "shale" gas deposits (Naumko *et al.*, 2013).

Therefore, it is important to study the volatiles of fluids owing to which the formation and transformation of deposits of prospective gas-bearing sections of the region occurred (Naumko, 2006). Volatiles have a great influence on the processes of minerogenesis. It was their regime that determined the intervals of the fluid's functioning, the parameters migration of their components, and their disintegration under definite physical-chemical conditions promote developing of the phenomenon of heterogenization that leads to the change of such important parameters of the fluid medium of the mineral crystallization as an aggregate state, a concentration, acid-alkali and oxidoreductive indications.

According to Zinchuk *et al.* (2002), the formation of veins and veinlets in the deposits of the Lviv Paleozoic Depression is connected with catagenic and post-catagenic processes. The earliest Carbonate concretionary formations are represented by siderite, sideroplesite and ankerite, with dissemination of pyrite.The veinlet formations in rocks of the Upper Devonian are represented by the veinlets of milk-white and grey calcite, often with admixture of pyrite about 20 mm thick. Veinlets of anhydride-calcite composition, veinlet-like secretions of greenish hedromica and pyrite are foud not often. In secretions of the Devonian D_3^1 in the area of Verbizh, a vertical veinlet of anhydrite 10 mm thick was found, along borders of which a thin edge (1.5 mm) of zonal rhombohedral crystals of brown dolomite are developed, on which later quartz, rarely scalenohedral calcite, pyrite, sphalerite grew.

The multistage character of veinlet mineralization as well as its polygenetic nature indicate, the coal genesis of a part of gases, and the influx of methane included in the deep-seated high-temperature fluid (Naumko & Svoren, 2003) through oil-conducting dislocations like the Belz-Mylyatyn fracture (Kalyuzhnyi *et al.*, 1975).

Two trends of evolution of HC systems were established: a) vertical zonality: transformation into oil-like mixtures and bitumen-like liquids and solid bitumen due to loss of volatiles; b) lateral zonality: substitution of oil-like mixtures for light essentially methane fluids (Zinchuk *et al.,* 2003).

In the lviv Paleozoic Depression, the following types of HC-water inclusions were identified in Devonian and Carboniferous deposits: oil-like mixtures – one- and two-phase, with homogenization temperatures of 30-128ºC and syngenetic with inclusions with drops of yellow oil; inclusions of liquid and gas-like mixtures of volatile HCs with predominance of methane of gas-condensate type; two-phase inclusions of brown and red-brick bitumen; one-phase inclusions of supercritical methane of high density (Zinchuk *et al.*, 2001). The temperature of fluid environment was not lower than 160–200ºC. On condition of rising movement of fluids it fall 15–20ºC per 100 m (Kalyuzhnyi *et al*., 1975, Zinchuk *et al*., 2003).

Based on methane predominance (up to 100 vol. %) and the appearance of ethane (first %) at deeper horizons in volatile of fluid inclusions in minerals and closed pores of graptolite argillites of Silurian of the Lviv Depression, conclusions (Naumko *et al*., 2009, 2013) about the availability of conditions for the gas forming processes by a way of transformation of the organic mater into "shale" gas were drawn. The absence of steam testifies the "dryness" of the HC-containing system and low values of the gas saturation testifies the transformation of the organic matter under low (mainly lithostatic) pressures. At the same time, an order of magnitude higher relative gas saturation of veinlet calcite with which subvertical fractures in the argillite strata are healed and the appearance of steam indicate the possible influx of the deep-seated migratory paleofluids.

Thus, the fluid phase that was formed under the influence of deep-seated factors (Naumko *et al.*, 2009) interacts with the rocks and changes their paragenetic associations. This promotes determining of the equilibrium in the system rock-external physical-chemical parameters (pressure, temperature). This causes the importance of further investigations of the deep-seated and sedimentary HC fluid systems based on fluid inclusions with the purpose of determining parameters of migration processes within the limits of the Lviv Paleozoic Depression emphasizing the methane (HC) specialization of fluids.

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