The article deals with the current state of mineral and raw hydrocarbon base of Ukraine. The main promising directions of geological exploration for oil and gas are identified and determined: in reef-carbonate complexes, deep-seated petroliferous complexes, crystalline basement, non-anticlinal traps in sandy bodies, non-traditional HC sources. Key words: hydrocarbon potential, oil and gas fields, reservoirs, traps.

Ukraine are among of very limited number of countries-pioneers in the petroleum geology and hydrocarbon industry fields. There is no line in development of oil and gas (from prospecting and exploration on land and sea and different technical problems – up to and including oil and gas transport, building of gas-holders and so on), where Ukraine was not among pioneers. And at the present time in spite of long-term intensive mining, hydrocarbon potential of Ukraine is sufficiently powerful. In this respect the very significant is the fact that all ranges of oil and gas bearingness practically completely correspond to the Worlds ranges. So, the stratigraphic range of petroliferous formation in Ukraine is from pre-Cambrian to Pliocen including. So, the stratigraphic range of petroliferous formation in Ukraine is sufficiently powerful. In this respect the very significant is the fact that all ranges of oil and gas bearingness practically completely correspond to the Worlds ranges. So, the stratigraphic range of petroliferous formation in Ukraine is from pre-Cambrian to Pliocen including. Ukraine hydrocarbon and bitumen accumulation reservoirs are represented with all known sedimentary rocks and facies. The depth interval of commercial hydrocarbons pools distribution varies from first hundred meters almost to 7 km and apparently more than 8 km. Deep petroliferous basins in Ukraine various from typically toxically components.

Phase-geochemical diapason includes all known in the World types of hydrocarbons natural systems: from all kinds of natural bitumens and heavy oils to various gas-condensates (including pools of critical state) and all types of hydrocarbon gases. To this should be added that Ukrainian oils gascondensates and gases are distinguished with high quality and not contained admixed toxically components. There are many promising territories in Ukraine occupy about 80 % of total Ukrainian territory. Three petroliferous regions are known in our country (fig. 1): Eastern (Dnieper-Donets) region including Dnieper-Donets depression with adjacent monoclinal slopes of the Donets depression with adjacent monoclinal slopes of the

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Voronezh crystalline massive and the Ukrainian shield, and also Ukrainian segment of Donets basin;

– the Western region includes together with pre-Carpathian foredeep and Transcarpathian deep, Liviv Paleozoic deep and Volyno-Podolian outskirts of East-European platform;

– the Southern (Azov-Black sea) region is the most geotechnically-heterogenous (it includes the southern slope of Ukrainian shield, Pre-Dobrogean, Indol-Kuban and Northern Azov deeps, Karkinit-Northern Crimean-deep, North-Western and pre-Kerchian shelves of the Black sea).

The degree of development of hydrocarbon resources of the Eastern region achieves 58 %. 252 oil, gas-condensate, gas and heterophase fields are discovered here. Nevertheless, this region leads both by unprospected HC resources category C1 + D (~ 2.2 billions ton of conventional fuel) and by so-called stock of structures (in other words, by number of determined according to geologic-geophysical investigation predicted-prospecting target objects) that account for 326.

124 oil and gas fields are discovered in the Western region.

The degree (stage) of development its hydrocarbon resources run as high as 45 %. Unprospected (undiscovered) resources account for 0.75 billions tons of conventional fuel. The stock of structures (target objects) is 165.

46 oil, gas and gascondensate fields are discovered in the Southern region. The degree of its development run as high as only 8 %, the stock of structures – target objects are 50.

Altogether in Ukraine over the whole preceding period it was extracted near 2 billions tons of conv. fuel. The amount of unprospected (undiscovered) HC resources (by category C1 + D) is 5.3 billions tons of conv. fuel. This assessment is particularily minimal because it does take account a number of considerable promising lines of oil and gas prospecting. But even this the most reliable and justified part of the predicted HC resources is more than twice as large as the cumulative extraction of hydrocarbons from geological formation of Ukraine. And this is only part of the potential HC resources.

Reef-carbonate complexes of Ukraine are very promising for oil and gas. The world’s characteristics of HC resources testify that not only for oil but also for gas and condensate by no means less than the HC resources of terrigenous reservoirs. It is sufficient to mention that the most gas fields connected with Permian and Triassic (South Pars) and Jurassic (Iolotan) carbonate formations.

Carbonate formations of various geological age play great role in Eastern, Western and especially Southern petroliferous regions. Their HC potential are proved, but their degree of development of their potential HC resources no more than 10 %. The main part of carbonate reservoirs resources doesn’t appears in those 5.3 billions of conv. fuel. Ukrainian because ukrainian petroleum geologists and geophysics had been for many years under wrong impression that carbonate formations are tight “plates” (Visean “plate”, Bashkirian “plate” an so on) and play the role of regional oil-gas proof thicknesses. But closer examination of them allowed to establish and maped a fuel are those that are provided by above mentioned stock of structures (target objects). These are far from distinct anticylne structures as it was in the past but and geophysics (particularly seismic) prospecting are quite another. The total stock of such target objects are sufficiently large. Their number is above 540 objects.

Top priority task is additional prospecting of the largest fields (fig. 2) and reanimation of exsousted productive reservoirs by the application of present-day methods. But the main strategic trends are connected with prospecting of reef-carbonate complexes and local bodies, deep and superdeep (more than 5,5–6 km) horizons, nontraditional and alternative resources.

It is precisely potential resources characterize HC potential of geological formation of Ukraine. Indicated 5.3 billions ton of conv.

1 – oil; 2 – gas; 3 – gas-condensate; 4 – oil-gas-condensate
number of barrier-reef zones and megatolls in the Devonian (fig. 3, 4), Lower Carboniferous (fig. 5, 6) and Lower Permian of Dnieper-Donets depression; in upper Jurassic of Pre-Carpathian foredeep (fig. 7) in the Silurian Volyn-Podolian (fig. 8) in upper Jurassic of the Azov-Black sea region (fig. 9). There are plausible evaluations for separate segments of reef-carbonate complexes. Minimal summary assessment of those segments is above 5 billions tons of conventional fuel. It should be emphasized that great fields may be connected with carbonate reservoirs (fig. 10 – for example). The number of such target objects are sufficiently great.

Non-anticline terrigenous traps. Their prospecting is very important separate trend of exploration for oil and gas pools and development of HC potential in all petroliferous regions of Ukraine. Non-anticline traps are connected substantially with various types of sandstone bodies and all of them are distributed in great stratigraphic and sedimentary-facies range in Ukrainian petroliferous region (fig. 11). As experience of old petroliferous provinces (such as Volga-Ural, Midcontinent and

Fig. 3. Schematic map of the distribution of the Lower Famenian reef-carbonate zones in the Pripyat and Dnieper-Donets depressions

1 – boundaries of the distribution of Devonian sediments; 2 – crystalline rocks of the Pre-cambrian basement; 3 – clastic deposits; 4 – sandy-clay deposits; 5 – clay-carbonate deposits; 6 – reef zones; 7 – fields; 8 – volcanic and volcanic deposits; 9 – domanikites

Fig. 4. Zadonsko-Yeletski reefs on the slopes of the Osma-kovsky Early Famenian paleo-depression (North at board zone DDD. Borkovska Area)

1 – faults; 2 – zadonski reef-carbonate bodies; 3 – carbonate-clastic deposits of the pre-reef plume; 4 – eleski flyschoid terrigenous deposits; 5 – depressed domanoids; 6 – limestones; 7 – dolomites; 8 – mudstones; 9 – sandstones; 10 – salt; 11 – volcanics
others) had testified the number of such traps are measured by many hundreds and thousands. Such pools are mainly of small sizes. But they have been clustered by extended zones with considerable proved reserves. The stock of such traps is very considerable. For example, this is sedimentary-paleogeological cross-section Lower-Visean black-shale suit with great number of petroliferous sandstone bodies in Dnieper-Donets basin (fig. 12).

And this cross-section (fig. 13) demonstrates clustering of bars that controlled the zone of intensive gas accumulation (great Abazovo-Sementsovka gas condensate and other fields in Serpukhovian (C1) facial-cyclic deposits (Dnieper-Donets depression). There are many other examples of HC pools in sand bodies of various types in wide sedimentary-facies range. Together with elementary sandstone bodies complicated terrigenous bodies of more large size are of wide spreading.
Fig. 6. Prospects for the Oil and Gas potential of the Walsort domes of the central part of the DDD at the depths of more than 5 km
1 – isohypses of the reflecting horizon Vv2-п (by to the CDPM seismic data); 2 – salt stocks; 3 – fields with gas-condensate deposits at depths of more than 5 km; 4 – localization sites Walsort domes

Minimal assessment of total HC resources connected with nonanticline traps in terrigenous reservoirs is about 0.5 billion units of conv. fuels (half trillions m³ of gas or half billions tons of oil).

All above-mentioned types of petroliferous traps are quite traditional in the World, but not completely traditional for Ukraine. So, we have great reserves connected with such pools.

Deep-seated petroliferous complexes. In due time just the great depths had been saved Ukrainian oil-gas exploration branch, oil and gas industry. Moreover, just owing to this line of prospecting and drilling, extraction of natural gas in Ukraine ranges up to about 68–70 billions m³ per ear (in seventies years of XX century (fig. 14). Tremendous (without any overestimation) ukrainian achievements in development of deep-seated HC pools (particularly discovery of 46 fields – with ~110 gascondensate, gas and also

Fig. 7. Petroliferous Upper Jurassic barrier reef within the North-Western part of the external Pre-Carpathian depression zones. Typical Geophysical Section Characteristics Facial Areas by Data Well Logging
Fig. 8. Silurian Barrier-Reef zones (paleogeomorphological section of the Lokachinsky area)
1 – reef carbonates; 2 – pre-reef clastic-carbonate deposits; 3 – clay limestones; 4 – sulphate-carbonate deposits; 5 – marine limestones and dolomites; 6 – oolitic limestones and calcarenites.

Fig. 9. Reef zones of Southern petroleiferous region of Ukraine

Fig. 10. Great forecast Gas-Condensate field in one of the deep-lying Tournaisian reefs of the DDD
1 – sandstones; 2 – mudstones; 3 – depressive limestones; 4 – reef-carbonate; 5 – forecast gas condensate reservoir; 6 – forecast hydrocarbon deposits.
oil-gas pools at the depth more than 5 km) are of great practical and theoretical significance for the present-day mastering of deep and superdeep depths in the World. Just in Ukraine, especially in central part of DDD secondary reservoirs with various manifestations of dilatancy and other types of deconsolidation (fig. 15) were investigated the most completely just from such deep-seated reservoirs great stable gas debits were obtained.

Presence of superreservoirs – intervals of intensive open fracturing and cavernosity is established within zones of current tectonic stress. Recently, such productive superreservoirs were

Fig. 11. Main morphogenetic types of terrigenous bodies – hydrocarbons traps
established at the depth more than 6 km in Semirenkivske gas-condensate field (Poltava region, central segment of DDD). Their evidence is self-decomposition of cores into thin discs with condensate and light oil films. According to a set of data such intervals are typical at the depths 5–7 and more kilometers. Deep-seated gas-condensate fields are at the stage of pool accumulation process according thermobaric, hydrogeologic, isotope-geochemical data (fig. 16) with the pace that comparative with velocities of HC-fluid intensive extraction.

Within Poltava-Kharkov segment of the DDD that situated above Dnieper-Donets mantle plume there are localized the bulk part of prospected HC reserves and the most of potential resources of Lower Carboniferous – the main petroleum floor of the Eastern region. There are many very promising targets objects connected with deepseated terrigenous and carbonate reservoirs in this segment of DDD (fig. 17).

Crystalline basement of different age (particulary pre-Cambrian) shows considerable promise of HC potential. This problem needs in special consideration in Ukraine. Now one can only to mention that just in Ukraine commercial HC potential AR-PR crystalline basement. The question is about intensive oil-gas accumulation in Eastern segment of joint zone between Voronezh anteclysa and DDD – Donets basin. Seven fields including great Yuliivka oil-gascondensate field have been discovered here.

A number of such zones are predicted within dilatansion zone within crystalline basement of Eastern, Western and Southern petroliferous regions.

Among indicators of such objects one ought to mention pools of gas in traps, connected with bazal strata of sedimentary cover.

An additional point to emphasize is that we predicted big and gigantic oil gascondensate and gas fields connected with massive reservoirs of deconsolidated Paleozoic – Early Mesozoic granites on the North-Western
Fig. 15. Secondary fracture-cavernous-porous reservoirs in metasomatic-transformed quartzitic sandstones of Lower Carboniferous (central part of Dnieper-Donets Depression, at the depth of 5–6.5 km).

Fig. 16. Deep hydrogeologic anomaly in Machukhi field (Dnieper-Donets Depression)
1 – sandstones; 2 – clay limestones; 3 – reef carbonate; 4 – silt-clay deposits; 5 – movement of deep supercritical HCl-fluids; 6 – gascondensate pools; 7 – supossed pools of critical state; 8 – brines of Cl-Ca type; 9 – low-mineralized condensated waters of hydrocarbonate-sodium type.

Fig. 17. The central segment of the Dnieper-Donets depression. 45 fields (~ 110 pools) at the depths of > 5 km.
and pre-Kerchian shelves of the Black Sea. The question is about fields of White Tiger, Dragon and other (fig. 18).

**Non-traditional HC sources.** This trend has been seemingly very promising ten or even 5 years ago. Then the objects of shale gas were determined and prospecting works have been begun on Olesskaya (Lviv and Ivano-Frankivsk regions) and Yuzivska (Kharkive and Donetsk regions) areas. One ought to mention those objects were not the best. All efforts to develop this promising trend proved to be in vein by virtue of ecological and geopolitical reasons. Nevertheless, we argue with full responsibility argue that Ukrainian regions and Dnieper-Donets region first these are inexhaustible nontraditional source of gas during which shale, central-basin and free gas are deeply intertwined. This figure (fig. 19) demonstrates powerful Srebnian areal of gas-saturated Visean black shales. Their as evidenced by results of laboratory investigations and field tests. They are characterized with great content of kerogen and anomaly radioactivity. Bodies of good sandstone reservoirs with gascondensate pools occur within this black shale formation (particularly of large Rudovka field) (fig. 20). The development of such fields must be realized so in order together with free gas from sandstones with effective porosity, to extract shale gas.

Another good case in point – Rudenkovske gas field (fig. 21). Here together with considerable proved reserves of gas in terrigenous and carbonate reservoirs (blue colors), tremendous resources of shale and gas (Lower Visean black-shale suite) and central-basin gas (Upper Visean thickness of black-shale-sandstones thin intercalation).

We believe that the development of such hybyride predominantly gas fields will be the very important trend of development to commercial level of the fields production capacity. Numerous oil zone of Carpathian region may be among them in sight. Here traditional oil pools in sandstones are combined with gas-saturated of Menilite black shales with intensive-fracturing caused by disjunctive-plikative tectonics.

It is pertinent to bring in mind that Ukraine has great reserves of coalbed gas and non-exhausted resources of methane dissolved in underground waters of abovementioned regions and connected with gas-hydrates of the Ukrainian segment of the Black Sea.

From the aforesaid, it may be seen that collapse of Ukrainian fuel-energetic complexe is caused not by mythical exhaustion of natural HC resources but by collapse of the bulk of geophysics exploration and deep drilling (fig. 22).
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