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METHODOLOGY OF THE HYDROCARBON POOLS PROGNOSING BY THE COMPLEX OF GEOPHYSICAL DATA

The proposed methodology is worked out for the aims of oil and gas geology and can be used at investigation of terrigenous, terrigenous-carbonate and carbonate sections. It can also be used at prospecting and exploration of coal, ore, diamond deposits and underground water, as well as at the solving the tasks that need the detailed knowledge of the section structure (gas storages, slide dangerous zones etc.).

The methodology includes the new methods and techniques of processing and interpretation of geophysical data. It is realized as a programme-methodical complex (PMC) "Seismocyclit" and AFCM (amplitude-frequency characteristic of medium). It is based on the theory of sedimentary cyclicity – lithmology (the teaching about rock-formations associations, which are characterized by the sum total of certain indications and are called the cyclits) and on the assumption of discompaction and compaction zones existence (the zones of reservoirs and cap rocks development).

The PMC "Seismocyclit" and AFCM peculiarities are as follows:

1. Combined processing and interpretation of the data of various geophysical fields (seismic survey, electrical prospecting, well logging) with the presenting of resultative data in the identical form – the form of seismocyclits. The seismocylit is the representation of the cyclit in the field of reflected seismic waves.
2. Application of new methods of wave fields processing, include:
   – method of weakening the regular noise-waves, which do not answer the principle of mutuality in seismic survey;
   – method of side waves influence compensation;
   – method of coloured sections formation.
3. Using the new methods and techniques:
   – method of seismic waves tying to depth;
   – method of seismic waves correlation;
   – technique of hydrocarbon pools forecasting with use of the wave field regular and noise constituents.

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The uniting of the known geophysical methods and techniques, which were tested by time with the worked out by us techniques of processing and interpretation have led to creation of the new instrument for geological investigations. The advantages of our methodology in comparison with the commonly used methods consists in the possibility of obtaining the new qualitative data as to geological structure of the studied areas, which permit to carry out the forecast of hydrocarbons pools.

The technique of hydrocarbon pools forecasting is based on the hypothesis that an oil and gas field is formed in consequence of hydrocarbons migration from the source of their generation and subsequent accumulation and conservation in the traps that are on the paths of migration.

According to this hypothesis the search for oil and gas pools consists in the following:

- the search of main migration paths-supply conduits;
- the search of traps connected with these supply conduits;
- forecast of hydrocarbons presence in the trap.

The main paths of migration – supply conduits – are subvertical zones, which are being formed as a result of rocks discompaction.

The hydrocarbons trap consists of the reservoir (discompacted rocks) and the impermeable seam (compacted rocks, that limit the upper and lateral parts of the reservoir).

The reservoir of the trap should be connected with the supply conduit. The connection of the reservoir with the main path of migration – supply conduit – may take place directly or through additional paths of migration. The additional paths of migration could be the separate permeable seams or subhorizontal discompacted zones [3]. The forecast of hydrocarbons presence in the trap is carried out on the base of a priori geologic-geophysical information and electrical survey data. The search of main migration paths-supply conduits, is carried out by means of seismolithmological sections (PMC "Seismocyclit") and AFCM sections plotting and interpretation. It should be noted that in the first case are used regular waves, in the second – non-regular (noise components of the same field). According to the theory of sedimentary cyclicity the sedimentary rock mass is made up of cyclits. Representation of the cyclit in the field of reflected seismic waves is called seismocyclit.

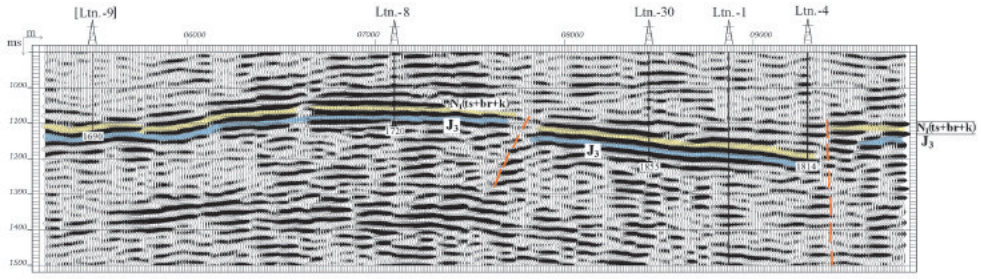

Fig. 1. Stacked black-white record of the profile (the field Letnia, Ukraine)

In the Figure 1 is represented a fragment of CDP time section with improved relation signal/noise. In the Figure 2 is shown a fragment of cyclit-section with well log curve diagram.

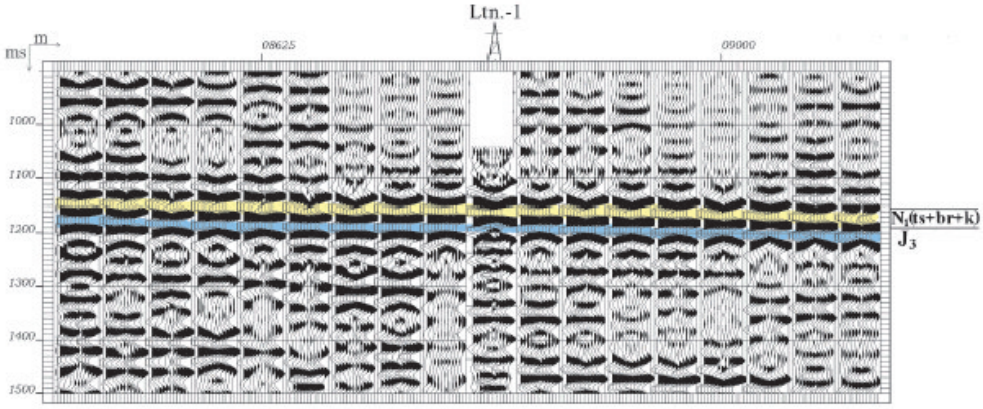

Fig. 2. Cyclit-section of the profile with cyclit-column (the field Letnia, Ukraine)

In Figure 3 – the coloured seismolithmological section with marked hydrocarbons supply conduits. In Figure 4 – a fragment of AFCM section on which in black colors become apparent the zones of reservoirs development, and in the white color – the zones of cap rocks development.

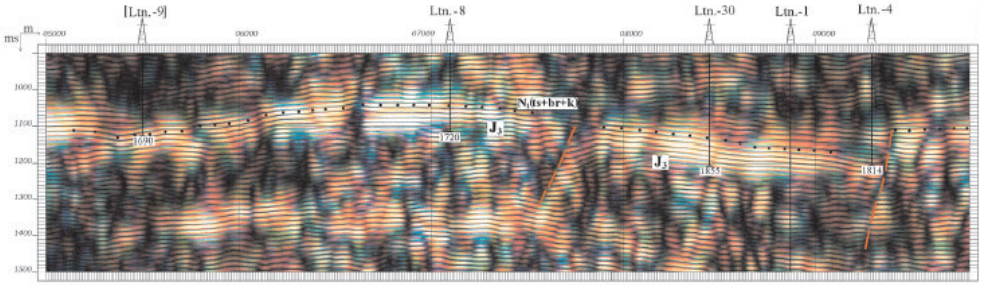

Fig. 3. Seismolithmologie section of the profile (the field Letnia, Ukraine)

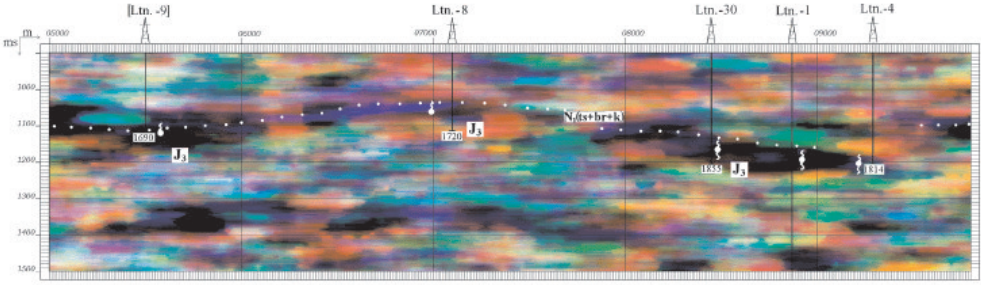

Fig. 4. AFCM section of the profile (the field Letnia, Ukraine)

The results of the technique use are illustrated on the example of two fields under development in Ukraine and Kazakhstan. The dark colors correspond to the zones of reservoirs development, and light – to the zones of cap rocks development, that is corroborated by the well drilling data (Fig. 5, 6).

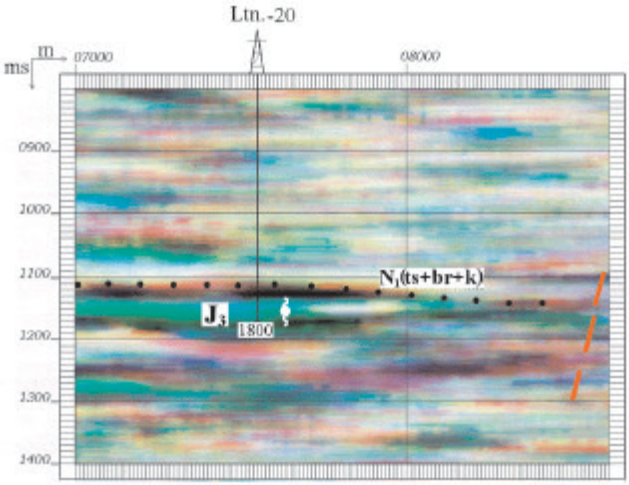

Fig. 5. AFCM section of the profile (the field Letnia, Ukraine)

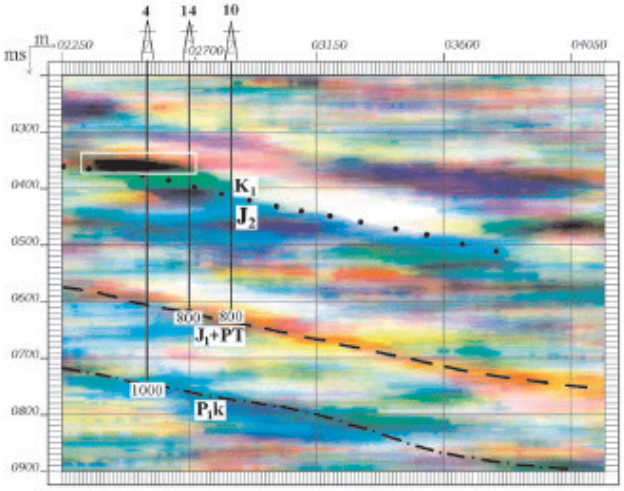

Fig. 6. AFCM section of the profile (Kazakhstan)

According to geoelectric model of the hydrocarbon deposits the deposit and epigenetical changed rocks containing it are characterized with anomalous behavior of longitudinal resistance [2]. Information about distribution of rock resistance can be received by electric prospecting method (SFN, Fig. 7).

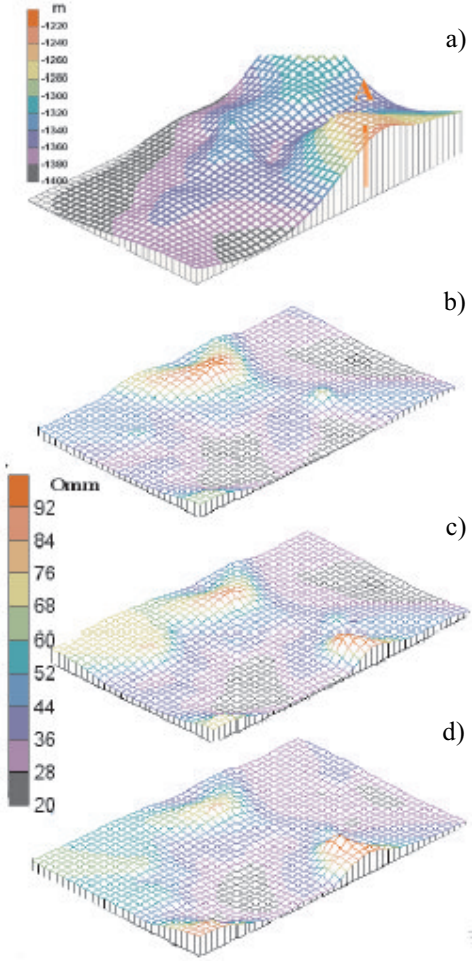

Fig. 7. Method of prognosticating hydrocarbon deposits (a) volumetrie picture of the surface of investigated sediments; (b, c, d) volumetric picture of longitudal electric resistance on different depth

The most effective processing SFN data is carried out with the help of integral method. Using PMC "Seismocyclit" volumetric picture of the succession is composed, the channels of migration, reservoirs and seals are revealed, presence of heterogeneity in the section are ascertained.

- The method of hydrocarbon pools forecasting using the seismic field noise and regular constituents is worked out.
- Realization of the method is carried out with use of programme-methodical complexes "Seismocyclit" and AFCM.
- The proposed method in the complex with well logging and electrical prospecting data permits to forecast oil and gas pools presence independently of section type.

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