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Studying of variations litho-stratigraphical complexes on the basis of the spectral analysis logging dates (on example western Uzbekistan).

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One of the main tasks in carrying out studies in geologically closed territories is stratigraphic partitioning of well profiles to fixed stratigraphic units. Usually this problem is solved with 100% core recovery. But in many cases core recovery is not done for all range of wells and even more so not in all wells.

In this connection when partitioning of well profiles and their further stratification takes place, we propose to use frequency characteristics of well-logging diagrams which describe the process and speed of sedimentation. The article is shown variety for different paleogeographical, tectonic and others conditions of sedimentation. It is necessary to note that frequency characteristics in this case are received from spectral analysis with the use of Furie fast transformation. Usually the spectral analysis is used for periodic signals which change in time. But well-logging diagrams are a periodic function in its representation, what allows subjecting them to Furie transformation. With that we need to have in considered adequate analogues with time representation of periodic signals. In particularly the periods upon frequency characteristics of signals, which change in time, will correspond to the capacity of frequency characteristics of signals which change by depth.

With the objective to reveal new diagnostic features in frequency area it is recommended to make spectral analysis of well-logging diagrams by certain logging methods which characterize the patches of profile in the best profound way. At that every independently selected complex characterizes its own field of geophysical parameters

in depth and spectral areas.
The specific feature of well profiles partitioning using the logging data on the basis of spectral analysis is the definition of frequency characteristics (frequency and amplitude) in given range. This allows determining frequency parameters of stratigraphic units of different range.

The spectral analysis is one of methods of mathematical processing the information which allows redistributing the set function on frequency components.

At the description of function of any physical phenomenon changing in space, speed of this change, i.e. frequency or wave number, becomes significant parameter. Similarly it is applicable for all periodic functions. In particular, wells profile diagram received as a result of geophysical researches in the wells, is periodic function changing with depth. Transformation wells profile diagrams in the frequency form of representation, does not mean addition something new, it is simple regroup the data in the other order; in other words, the data are grouped on frequency (or capacities to layers), instead of on depth. Value of such representation becomes clear even that the majority of the geophysical phenomena are theoretically expressed in the frequency-dependent form. Hence, this form of representation is more directly connected to the investigated phenomena. Moreover, some mathematical operations, for example, such as a filtration, are more easily carried out in frequency representation.

The spectrum used in geophysics, is the statistical size expressed mathematically which turns out from time or spatial functions by the certain transformations. Generally the spectrum is expressed as the sum of material and imaginary parts:

$$F(\omega)=a(\omega)-ib(\omega)$$

Product of material and imaginary parts:

$$F(\omega) = |F(\omega)|e^{i(\omega)}$$

Where $|[F(\omega)]|=[a^2(\omega)+b^2(\omega)]^{1/2}$,

$$\hat{O}(\omega)=\text{arctg}[-b(\omega)/a(\omega)]+2n\pi,$$

n=0, ±1, ±2, ...

In above mentioned expressions $F(\omega)$ there is a function of independent variable ω. It means, that $F(\omega)$ - a spectrum. If $a(\omega)$ and $b(\omega)$ characterize amplitude, $|F(\omega)|$ - a peak spectrum, and $\hat{O}(\omega)$ a corresponding phase spectrum.

According to any function satisfying conditions Direkhle, it is possible to present theorem Foure as the sum of infinite number sine wave composed. In our case investigated functions are wells profile diagrams which can be presented as functions f (h) for which conditions Direkhle are formulated as follows.

1. f(h) should be periodic, i.e. f(h)=f(h+2π), where 2π - the period. If f(h) - acyclic function, but is determined on a final interval the sum of sine wave members will converge nevertheless to f(h) on the set interval. Outside of this interval the sum will be recurrence f(h).

2. f (h) should be at least bit-continuous, and number of breaks certainly, and gallop - limited.

3. f (h) should have final number of maxima and minima.

4. Integral

$$\int_{-\pi}^{\pi} f(h)dh$$

Should converge, that follows from a condition 2.

As an example, we had been undertook attempt of carrying out of a partition of sections Jurassic adjournment on the basis of the spectral analysis of wells profile diagrams. The geology-geophysical characteristic of the section Low-Middle Jurassic adjournment of westeren Uzbekistan on the wells profile data, and in the resulting part of present article spectral characteristics of allocated complexes (LGC) below is resulted.

In the geological condition the territory of the western Uzbekistan is part of the Amudarjinskaj hollow. In the tectonic plan, within the limits of the Western Uzbekistan here are allocated Chardjou and Bukhara tectonic steps. From a position of oil-gas-bearing the given territory carries the name Bukhara-Khivan oil-gas-bearing area.

On the Chardjou steps Bukharo-Khivan oil-gas-bearing areas terrigenoues Jurassic adjournment are completely opened on a number of the areas: 2-North Parsankul - 490m., 1p-Sarikum - 581m., 1p-Beshtepe – 598m., 1p-Kruk – 683m., etc.). In the wells 1p-East Uchbash thickness of these adjournment reaches 893m, 1p-Uchbash – 983m. The maximal thickness is marked in the wells 4-Kimirek - 1400ì. Apparently in researched territory of thickness change from 490 up to 1400m and more. Thus the increase in thickness occurs as due to bottom part of section, and its average part.

By results of interpretation of wells profile materials with use of the description of the core, Low-Middle Jurassic adjournment lithologically are submitted clays, argillites,

aleurolites, sandstones, with pro-layers grit-stones and coals. The bottom part of adjournment was formed in continental conditions. One researchers consider, that deposits valley-type plain-facial zones (Makarova 1976, 1979; Egamberdiev 1978, 1981), others sub-mountain flabellate (Troitskiy 1967). The top part was formed in sea (basin) conditions.

The partition and correlation the sections of terrigenous Jurassic adjournment in view of their big facial variability and presence of a plenty of breaks and non-conformity is a difficult problem. Thus we took into account results spent by various researchers (Rizaev, Romashko 1976; Tal-Virskiy, Romashko 1979; Babayev, Gabriliyn 1978, 1991; Popov, Romashko 1984; Alexeev, Eremenko 1988, 1991, 1994; Kernoz, Beznosov, etc. 1989; Salymova 1990; Terekhov, etc. 1992; Tal-Virskiy, Romashko, Radjabov 1996 and many others).

At research terrigenous Jurassic adjournment of Bukhara-Khivan region there are certain difficulties.

First, stratigraphically partition of terrigenous Jurassic adjournment of Bukhara-Khivan region is based on materials on exposures of Southwest spurs of Gissar. During too time even in this region the data on exposures with the big difficulties coordinate with the data on wells, and it especially concerns to areas removed on tens and hundreds kilometers.

Second, stratigraphically circuits developed for Southwest spurs of Gussar cannot be distributed without corrective amendments to the removed areas Bukhara-Khivan region since even within the limits of itself Chardjou steps, inter-areas correlation terrigenous Jurassic adjournment causes the certain difficulties both many researchers a partition and correlation of the given adjournment carry out on miscellaneous.

Thirdly, terrigenous Jurassic adjournments, in area of research are opened on full capacity by the limited number of wells, which in turn reduces quantity of the received geology-geophysical information.

Fourthly, the insignificant output core material, for a researched interval on the section of wells cannot provide creation rigid stratigraphically a basis at a partition and correlation of sections of wells.

And at last, fifthly, it is necessary to note, that the section terrigenous Low-Middle Jurassic adjournment has the same monotonous character of a structure; their partition and correlation on the wells profile data demands system engineering the diagnostic attributes consisting in specific data processing of trade geophysics in a complex with the data of drilling and mathematical processing of wells profile diagrams.

As objective material for specification stratigraphically units in the geologically closed areas, alongside with researches of a core, the data of geophysical researches of wells - continuously describing sections in geophysical parameters, and their display serve in view of mathematical processing of wells profile diagrams.

At a partition and correlation sections of wells we had been used a complex of wells profile data consisting from electrometric, core-metric, radioactive and acoustic methods. Under diagrams of these methods the information on seeming specific electric resistance of the rocks composing a section, measured a gradient is received by probes; potential differences of spontaneous polarization Usp, arising on borders between various on lithology and mineralization of underground waters breeds, change of diameter of a wells, intensity a natural background of radio-activity Ij and the secondary - radiation Jnj, being indicators of clayness and porosity accordingly. Also under the diagrams of gamma-gamma methods is received the information on density of the rocks opened by wells, and values of speeds of run of ultrasonic wave Vp under diagrams acoustic methods are determined.

As a result of researches according to listed above methods of wells profile the partition of the section terrigenous Jurassic adjournment on natural geological bodies - the layers possessing a certain set of geophysical attributes has been made. Sets of layers were united in lithology-geophysical complexes (LGC). In a basis of allocation LGC alongside with the maximal, minimal and average values of geophysical parameters the configuration wells profile diagrams, including indented the diagrams, expressed by quantity of anomalies on the certain deep interval which characterize lamination of the section, and the scope of anomalies showing a variety of geophysical parameters in the section also has been used.

Besides all above-stated we for the first time for partition sections of the wells had been applied the spectral analysis of the wells profile diagrams for everyone LGC, given new diagnostic attributes for their comparison. Thus, on the wells profile data with attraction of spectral characteristics, the basic circuit of a partition terrigenous Jurassic adjournment has been made, and has been established, that the given section is expedient for dividing into five lithology-geophysical complexes (I-V from below upwards), each of which is characterized by the field of geophysical parameters in deep and spectral areas.

Adjournment I LGC in the basis of the section in hollows pre-Jurassic relief in which general thickness terrigenous deposits of Jurassic exceeds 700 m. This LGC is a complex of leveling, smoothing first of all pre-Jurassic surfaces. In area Karakulsky deflection it is present at sections of the wells 4-Kimirek (248 ì), 1-Kimirek (75 m - opened thickness), 1Ï-Uchbash (249 ì), 1Ï-East Uchbash (188 ì). Section of I-LGC is

confidently traced on the wells profile diagrams enough. On diagrams of electrometric, this complex is characterized by rather high values Đk varying from 10 up to 50 Om.m..

Adjournment of II-LGC with stratigraphically non-conformity lie on under-laying adjournment of I-LGC (4, 1 Kimirek) and with sharp angular and stratigraphically non-conformity on pre-Jurassic surfaces (1,2 Khodji, 2-Northern Parsankul). Adjournment of II-LGC (the bottom part gurudscay suite) is submitted by alternation of low-power pro-layers clays, aulerolites and sandstones. Deposits of this LGC are present at the sections in the wells 4-Kimirek (432ì); 1 Kimirek (345ì); 2-Northern Parsankul (341ì); 2-Khodji (256ì). Strong indented diagrams of electrometric, carried out by gradient and potential zounds, testifies about thin-laminated section. Resistance, at the scope of anomalies reaching 8 Om.m., are characterized by the small values Đk changing from 4 up to 13 Om.m. Thus average level Đk = 7-8 Om.m.

Adjournment of III-LGC (the top part gurudskay suite) have local distribution and are traced in area near wells 4-Kimirek (623 m.), 1-Kimirek(270 m.), 1Ï-Uchbash (613 m.), 1Ï-East Uchbash (554 m.), 2-North Parsankul (61 m.). The given complex is characterized triplex structure. Bottom part of LGC is submitted by alternation of sandstones, aleurolites and clays. On the wells profile diagrams the given part of this complex is characterized be relative by the average values Đk varying from 4 Om.m. Up to 15 Om.m., at average values Đê=8 Om.m. and small scope of anomalies.

Adjournments of IV-LGC (degibadamskay suite) are submitted basin and coastal-sea sandstones, aleurolites and arilites. This LGC in area Karakulskiy deflection it is distributed locally and is present at area near wells 1-Kimirek (50 ì), 1-North Khodji (180 ì). On other areas it apparently is destroyed pre-baisunskiy by washout. Absence of communication is typical of adjournment IV-LGC between speed and electric properties of rocks. Sizes of seeming resistance of this LGC rather high in comparison with higher and under-laying complexes and vary values in limits from 8 up to 55 Om.m., at an average level 25 Om.m. High values of resistance are connected on seen with argillization clay breeds.

Adjournment of V-LGC (baysunskay suite) are submitted by typically sea deposits and traced on all area of research. On the lithologically structure in it sandstones and aleurolites with low-power pro-layers of limestones and marle are allocated carbonaceous clay. The given complex lies as on adjournment IV-LGC (1-Kimirek, 1-North Khodji), and on dim surface III-LGC and II-LGC with sharp angular and stratigraphically non-conformity (4-Kimirek, 1Ï-Uchbash, 1Ï-East. Uchbash, 2-North Parsankul, 1-Khodji, 2-Khodji, etc.). Thickness of the V-LGC is insignificant and changes from 89 m. (2-north Parsankul) up to 164 m. (1-North Khodji). In bottom part of LGC it is

located basal horizon of sandstone which is precisely allocated on the maximal negative anomaly Usp. Values Đê are minimal (Đk=3-10 Om.m.). Overlying on the section the powerful clay layer is allocated on increase in diameter of the wells. Values Đê in given part of LGC varies from 3 up to 15 Om.m. Weak differentiation of anomalies Usp, varying in limits from 0 up to 15 mV testify to sea mode sedimentation. Above on the section the V-LGC it is submitted inter-banded by sandstones, aleurolites and carbonaceous clay.

As we saw from consideration of geophysical characteristics allocated LGC distinctions in geophysical parameters terregenous Jurassic adjournment behind exception V-LGC are not too great, that has led to the big divergences in a partition and correlation of sections various authors. In consequence of it we have made attempt to expand diagnostic criteria separate LGC due to the attributes contained in spectral representation of wells profile diagrams.

The spectral analysis characterizes two parameters: complex, often different frequency rhythmicity and thickness of layers. For calculations fast transformation Fuere to system FTF is used. Calculations were made on diagrams of gradient zounds and gamma method. Input wells profile diagrams it was carried out by means of the tablet scanner, and numbering with the help of program Scandigit. Numbering wells profile diagrams was carried out discretely with step through 1 meter of a deep interval.

It is necessary to have in view of, that as a time-base in our case the axis of depths, therefore the periods of fluctuations in this case serves are equivalent to capacities of layers or rhythmical packs.

Attempts to receive spectra on all sample on everyone LGC appeared unsuccessful since amplitudes of low-frequency fluctuations much more surpassed amplitudes of the high-frequency fluctuations corresponding to low-power layers. Therefore the spectral analysis should be carried out in some, at least in two stages. On the first, the low-frequency background equivalent to capacities more of 20 meters which then is subtracted from record Đk is investigated. It is equivalent to application of the high-frequency filter. Then the spectral analysis on the rest after subtraction of a low-frequency component which is the most informative for diagnostics LGC was made.

Below brief data on spectral characteristics LGC are resulted.

I-LGC. The spectral analysis is carried out under diagrams of the gradient - zounds on the wells 4-, 1-Kimirek, 1Ï-Uchbash. The most typical attribute of it LGC is presence of one precise maximum of the frequency characteristic on the period (thickness) of 10 m. The disorder on various wells is insignificant (9 - 10.5 m.). Second attribute is the high amplitude on frequency of this maximum varying from 115 up to 210 on samples

in various wells. It is necessary to note, that alongside with this main extreme maximum in spectral area additional maxima which are much lower than the main thing were showed still. So in 4-Kimirek additional maxima on the periods of 3.8 and 2.7 m, but their amplitude in 1.5 have appeared - 2 times are lower than the main maximum. In 1-Kimirek the additional maximum has appeared on the period of 2.7m., with amplitude in 2 times below the main thing. And in 1Ï-Uchbash additional maxima have appeared on the periods of 3.8 and 2.7 m. with amplitude equal 50. Additional maxima in spectral area to some extent also are diagnostic since at rather small divergence in values of amplitudes their periods practically coincide on researched wells.

Spectral analysis II-LGC is carried out on 4-, 1-Kimirek, 2-Khodji. As a result of application to wells profile diagram of a gradient zounds of the high-frequency filter sample of the rest is received. Thin-laminated the section of the given sample in itself is diagnostic at allocation II-LGC. In spectral area for given LGC the congestion of the basic maximal extreme of amplitudes on the periods from 2.2 up to 4 m. is typical, thus values of amplitudes are minimal and vary in limits from 2.4 up to 8. The most minimal values of amplitudes for the given periods are marked in 4-Kimirek. It is necessary to note also, that in 4-Kimirek on the period of 6 m. the additional maximum in spectral area, which amplitude less main has appeared. On sample II-LGC in 1-Kimirek and 2-Khodji, the main extreme are concentrated on the periods 3.5 - 4 m., thus very low values of amplitudes also are observed.

Revealing of diagnostic attributes in spectral area for adjournment III-LGC is executed on wells 4-, 1-kimirek, 1p-Uchbash. Schedules of a high-frequency component given LGC are submitted Middle-layer by the section, in comparison with under-laying sample on II-LGC. Values of amplitudes in spectral area are characterized by the lowered values, as much as possible reaching 28. 1Ï-Uchbash though during too times in the wells 1-Kimirek and 4-Kimirek values of amplitudes are a little bit lowered and on the main maximum of the frequency characteristic their size makes 18 and 12 accordingly. Similarly spectral characteristic I-LGC the main maximum of the frequency characteristic is concentrated on the period of 10m., thus the disorder of the given frequency characteristic on various wells is insignificant and changes from 9 up to 15m.

The spectral analysis for adjournment IV-LGC is carried out in the wells 1-Kimirek and 1-North Khodji. The main diagnostic attribute of it LGC is not the individual extreme maximum of a frequency component, and disorder of values of the frequency characteristic, at rather identical indications of amplitudes. It is necessary to note a wide maximum of the frequency characteristic of the order peculiar only to this complex - 6m. in top, and the period changes from 6 up to 12 m. in 1-Kimirek, and from 8 up to 14m. in 1-North Khodji. Values of amplitudes in a maximum vary from 60 up to 160 accordingly on the named wells.

Spectral analysis V-LGC is executed on the wells 4-, 1-Kimirek, 1Ï-Uchbash, and 2-Khodji. As a result of application to the wells profile diagram of the gradient zond to the high-frequency filter the received schedule of the rests is characterized thinness section. In spectral area the main maximum of the frequency characteristic is concentrated on the period about 20m. On all analyzed wells. However alongside with the main extreme maximum of the frequency characteristic, minor maxima of amplitudes which in some times there is less than main thing are here too observed. Values of amplitudes in a maximum of the frequency characteristic, on the data on various wells vary in small limits and change from 24 up to 34. Exception is the wells 4-Kimirek in which value of amplitude in the extreme indication of the period, reaches 75.

As a result of the carried out analysis of wells profile diagrams with attraction of spectral characteristics it is established, that LGC specific geophysical parameters that is especially precisely shown in spectral area are inherent in everyone.

So for allocation I-LGC alongside with high values of resistance, speeds, the big inrushes on core-metry, diagnostic criterion in spectral area are high values of amplitudes on the period about 10m.

Distinctive attribute at allocation II-LGC is thin-laminated section which in spectral area is characterized by high-frequency record with the minimal values of amplitudes.

For adjournment III-LGC, alongside with distinctions in geophysical parameters on the wells profile diagrams, in spectral area the lowered values of amplitudes are characteristic at the maximum on the period about 10m.

The main diagnostic criterion of allocation IV-LGC is rather high indications of resistance of rocks, at rather low values of speeds. In spectral area this LGC it is characterized by rather high values of amplitudes, at flat top and the big width of a maximum of the frequency characteristic.

Adjournment of V-LGC rather confidently are allocated on wells profile data, the bottom border given LGC is a sole basal horizon of sandstone which is confidently allocated under diagrams standard wells profile enough. In spectral area given LGC it is characterized thinness section and the maximal values of amplitudes are concentrated on the period about 20m.

In the diagnostic field of spectral characteristics it is visible, that areas of these attributes for separate LGC practically are not blocked, that does their application for a partition and correlations of sections rather effective.

The literature

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