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# Integrated geological interpretation of remote sensing data (Boysun structural-tectonic zone)

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**Abstract.** In recent years, remote sensing data are increasingly used in the practice of oil and gas prospecting. This article discusses the main methodological aspects of identifying oil and gas promising structures by using materials for interpreting remote sensing data and a complex of geological and geophysical data. Remotely sensed data exhibit a regional review of the various geological formations and tectonic fracture zone and faults that are otherwise not possible detection by human eyes on the ground. The method of structural interpretation space image allows you to: detail the internal structure of oil and gas regions; to reveal the position and features of the tectonic blocks, structures of the second and third (anticlines, synclines, monoclines, etc.) orders; identify major disruptive violations; identify chains of local structures; fix the transverse structural elements that determine tectonic fragmentation. By deciphering the remote sensing data, the distribution and nature of the lineament network marking disjunctive dislocations and zones of increased fracturing are revealed and analyzed, as well as ring structures are detected, which in most cases indicate local structures of the sedimentary cover at different depth sections. The lithology and lineament interpreted from these multi-level data were integrated with data collected from the ground.

## 1. Introduction

The first information about the geological structure of the Surkhandarya megasyncline was given in the works of P.P. Chuenko, and later geological survey works of various scales were carried out in the region by different researchers (Lupov N.P., Burachek A.R., T.Ya., Boldyshev V.V., Bunyak L.I., etc.).

Simultaneously with geological survey and drilling works in the Surkhandarya basin, geophysical studies were carried out using the methods of gravity, magnetic, electrical and seismic prospecting. Valshtein N.M., Lebedev B.N., Kuznetsov E.S., Akramov A.A., Fuzailov I.A., Yachmennikov Yu.M., Korobkov A.G., Ulmasov M.Yu., Yusufkhodzhaev Kh.I., Pavlovich E.I., Yugay A.P., S.V. Fomin, A.T. Babadzhonov, I.R. Akhmatkulov, N.P. Kakhkharov and many others took part in this work.

Of the works of ISIRNIGM employees in this region, the following work is close in terms of the problem being solved: Zonal and local forecast of oil and gas content of the Surkhandarya basin in order to identify priority targets for setting up regional and prospecting works for oil and gas (Baysun deflection) (Sitdikov B.B., 1992).

## 2. Study area



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The Surkhandarya megasyncline is one of the most promising oil and gas regions of Uzbekistan and at the same time the least studied of them (to the depth). For more than 70 years of prospecting and exploration work, 13 hydrocarbon fields have been discovered here, 12 of them, with the exception of the Gajak field, are small (figure.1). The main prospects are associated, first of all, with the pre-salt Jurassic sediments.

The region is characterized by a complex geological structure - intensive dislocation of suprasalt sediments of the sedimentary cover, the development of fracture tectonics, the formation of near-fault folds, and quite often the discrepancy between the structural plans of supra- and subsalt sediments. This is due, firstly, to the difficulty of identifying and preparing oil and gas traps under a thick cover of Neogene-Quaternary sediments, secondly, the occurrence of the most promising Jurassic and Cretaceous sediments at great depths, and thirdly, difficult geological conditions for drilling wells.

The presence in the section of the sedimentary cover of high-amplitude oblique faults, a thick salt-bearing stratum determines the discrepancy between the above- and below-fault, above- and subsalt structural plans and further complicates the identification and preparation of subsalt structures. And under these conditions, one of the main tasks is to increase the efficiency of geological exploration by improving the methodological options for prospecting and exploration of new hydrocarbon deposits. The use of space methods, including the interpretation of space survey materials, is currently one of the most promising areas in oil and gas geology.

### **3. Data used and methodology**

The methodology for deciphering the deep geological structure, geotectonic zoning and identification of objects promising for the identification of buried local anticlines - structural hydrocarbon traps, includes a number of successive and interrelated stages of work.

The first stage begins with the processing of the satellite image materials (image processing), then a specialized structural decoding of the satellite image is performed, the next stage is a morphometric analysis of new tectonic movements with the identification of promising morphostructural anomalies, and at the final stage, a comprehensive processing and interpretation of the results of decoding satellite image is performed with materials of previously performed geological and geophysical studies.

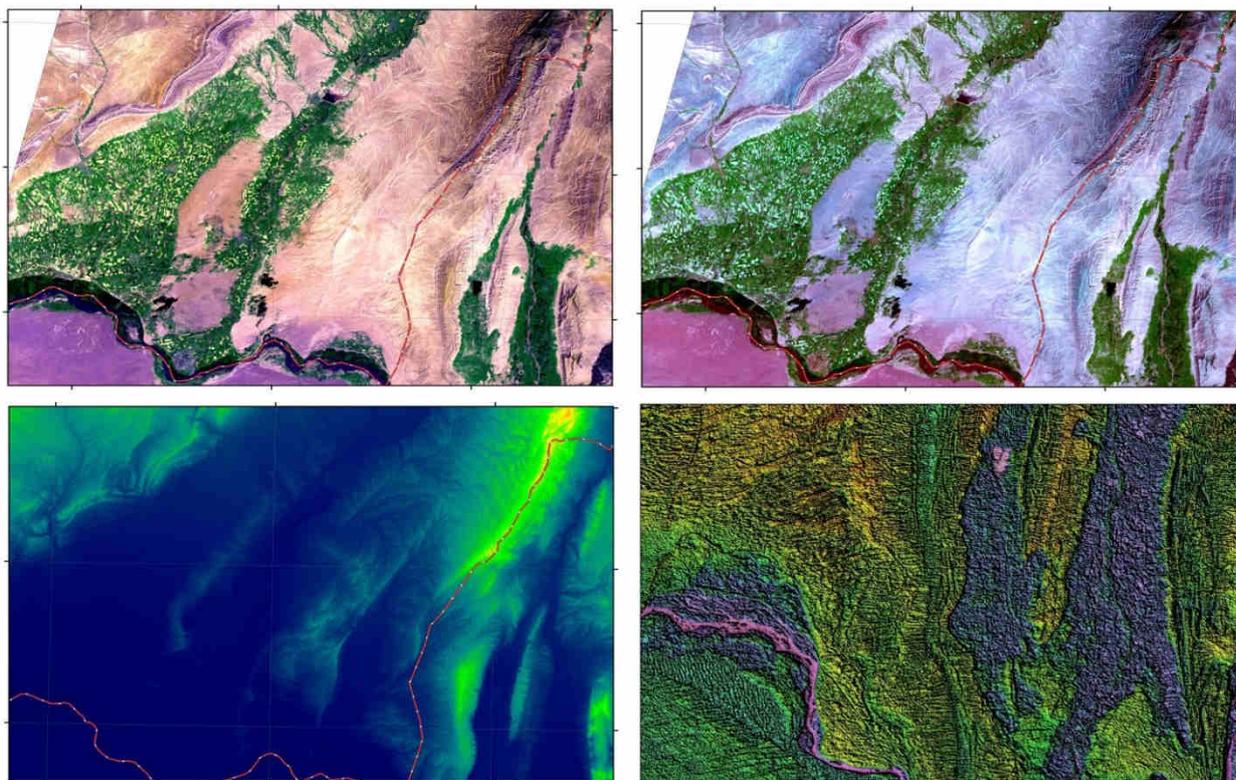
The initial research materials are spectrozonal images Land-sat 7 ETM +, Landsat 4.5, Aster Terra Look, digital elevation model - SRTM, topographic maps of scales 1: 200000, 1: 100000, for key areas 1:50 000. Necessary conditions selection of remote sensing data is: time of day, season of the survey, the presence of clouds, aerosol pollution of the atmosphere and other masking factors.

In order to improve the visual perception of an image, or transform it into a form more convenient for visual or computer analysis to improve the quality of images, various stages and stages of image processing (Image Processing) are performed to emphasize (highlight) informative elements. Taking into account the spatial heterogeneity of the landscape, using the Erdas Imagine software, linear and nonlinear types of filters are used, various types of linear and nonlinear contrasting (figure.1).

One of the most effective methods is the interpretation of the satellite image and the structural-geomorphological analysis of topo- and geo-maps. The use of space and topographic information provides clarification of the structural and tectonic structure of oil and gas areas, the study of structural forms with which hydrocarbon accumulations can be associated, and the identification of new promising objects for the localization and targeted implementation of various types of oil and gas exploration works.

Space image interpretation RS (remote sensing data) and topographic maps make it possible to outline the shape, size, plan position and strike of local objects (anticlines), trace lineament structural-tectonic elements (faults, flexures). Taking this into account, decryption materials make it possible to optimize the number of exploratory seismic profiles due to their orthogonal position in relation to the selected local objects [1].

Supplementing the existing set of geological and geophysical features of linear and area structural and tectonic objects with their deciphering features according to satellite image and topographic maps (comprehensive analysis of geological and geophysical and remote sensing data) allows increasing the reliability of the results and the geological and economic efficiency of seismic exploration.



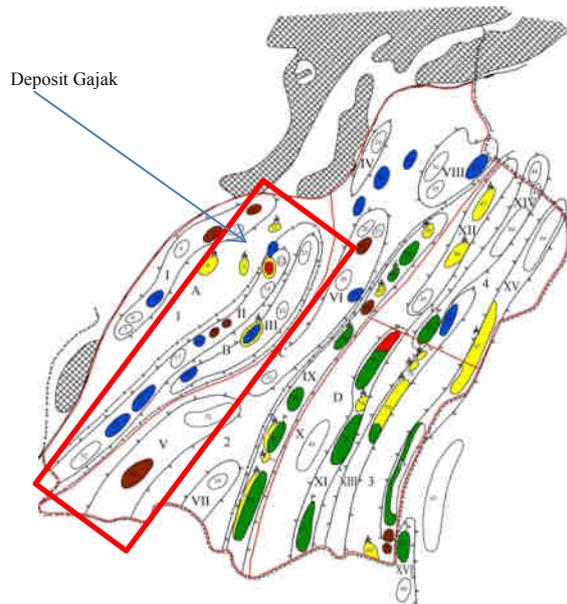
**Figure 1.** Fragments of synthesized satellite images of different spectral ranges of the electromagnetic spectrum of Landsat 7 ETM+ and radar topographic survey SRMT: a) Landsat 7 ETM+ in fusion [0.520-0.900 $\mu$  (pan), 2.09-2.35 $\mu$  mid IR, 0.630-0.690 $\mu$  thermal IR, 0.450-0.515 $\mu$  (blue)]; b) Landsat 7 ETM+ in synthesis [0.45-0.52  $\mu$  blue), 1.55-1.75  $\mu$  mid IR, 2.09-2.35  $\mu$  mid IR]; c) in the effect of high-altitude terrain classification SRTM; d) multi-frequency filtering.

The method, at a completely different level, makes it possible to synthesize and integrate the results of decoding satellite image (remote sensing data) and geological and geophysical data, which significantly increases the reliability and completeness of geological constructions, obtain information about previously unknown geological objects, and also increases the success of search and detection. accumulations of hydrocarbons [1].

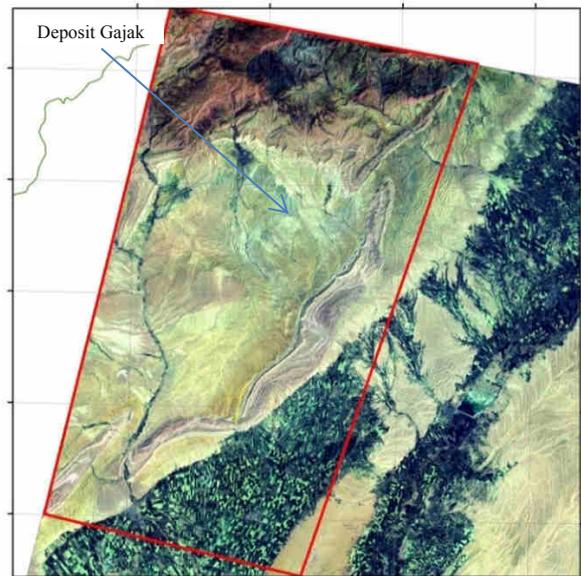
#### 4. Result and discussion

The Baysun structural-tectonic zone (Figure 2) is a promising region in terms of oil and gas, as evidenced by the Gajak natural gas fields identified within the eastern part of the region. Among other uplifts of the region, the Gajak uplift of the same name is best studied by seismic exploration and deep drilling. Contains hydrocarbon deposits in post-salt (Valanginian sandstones) and subsalt (Kell-Oxford carbonates) sediments. On the geological map, the uplift is well expressed due to the framing of the watershed Quaternary sediments and channels of large sais from the south-west, west and north-east [2].

On the same sides, the uplift is controlled by wide, gently sloping synclines (Baysun, Chombar, Inkabad synclines) traced in the Pliocene sediments. In the southeast, the structural boundary of the uplift (in the Miocene) is the narrow and steep Karagul synclinal. The Karagul syncline at the northeastern and southwestern boundaries of the Gajak uplift is attenuating, which indicates the spatial and genetic unity of the uplift and syncline (Figure 3).

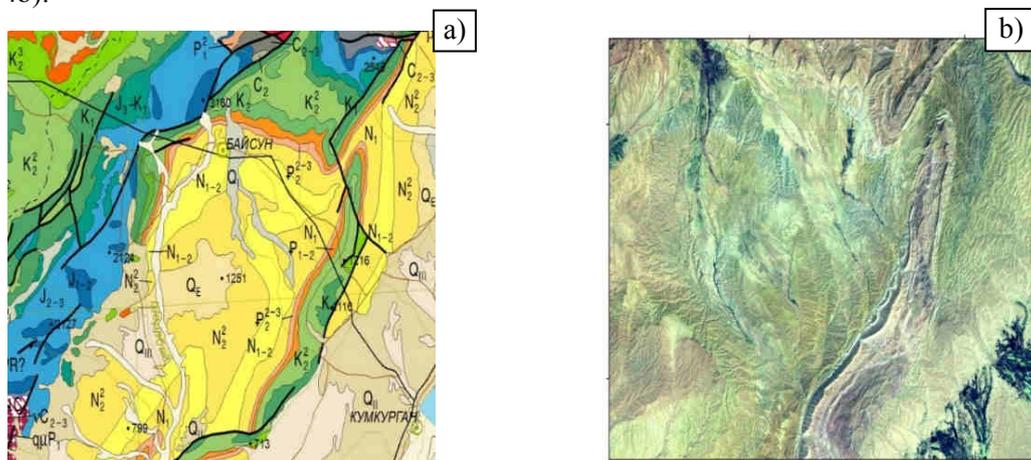


**Figure 2.** Layout of fields and oil and gas promising objects of the Surkhandarya region.



**Figure 3.** Fragment of a satellite image of the Boysun structural-tectonic zone.

According to the data of the satellite image interpretation, the uplift corresponds to a basin - an inverted inversion structural relief, in the Miocene sediments, filled with Quaternary sediments [1]. The near-arches of the wings, composed of strong bedrock sandstones, form a cuesta arc around the basin (Figure 4a). The uplift as a whole, judging by the bedding of rocks and the nature of the relief, plunges in the northwestern direction from the Gajak post-salt anticline conjugated with the Karagul syncline (Figure 4b).

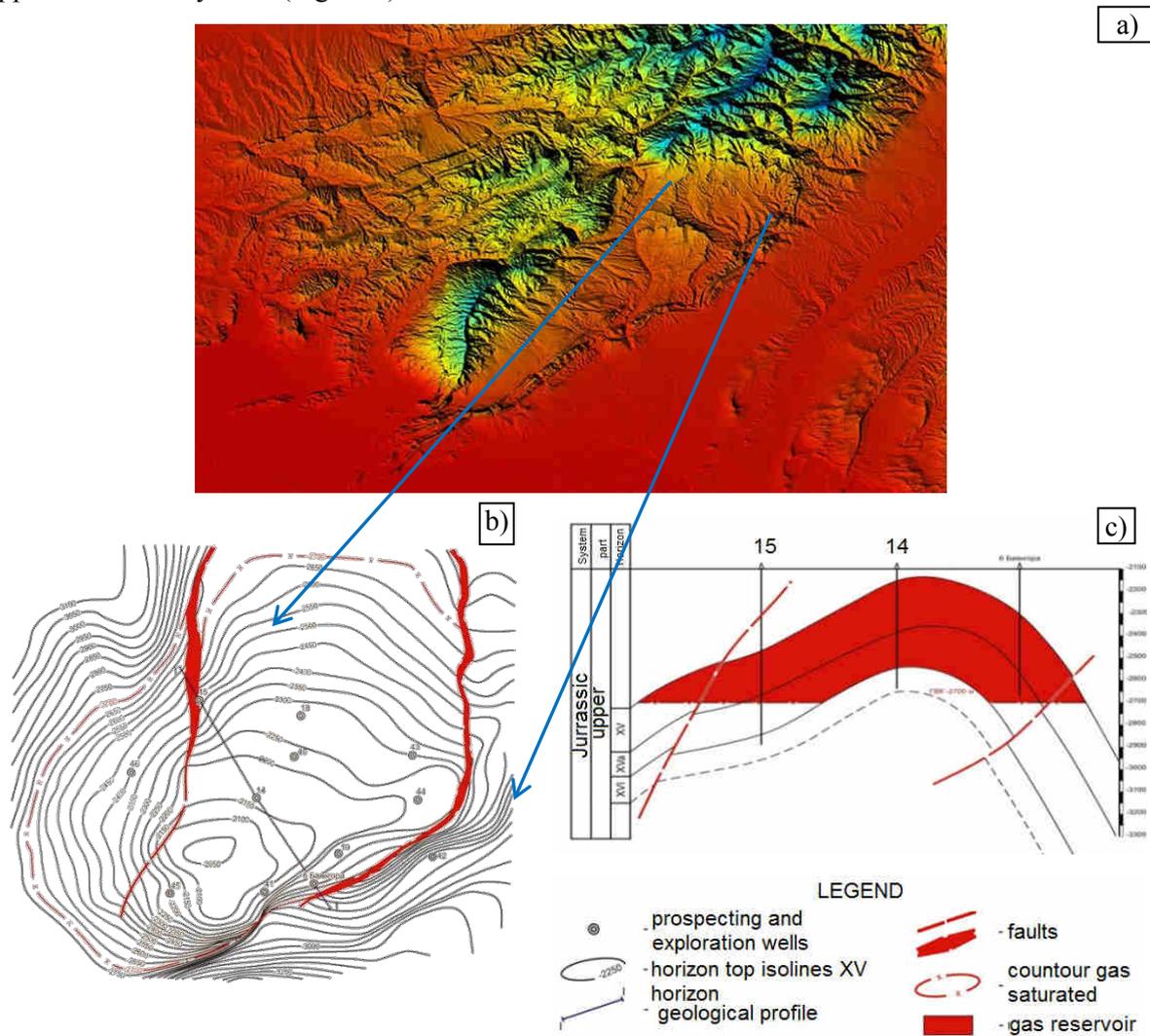


**Figure 4.** Local uplift zone Gajak: a - a fragment of a geological map; b - a fragment of a synthesized Landsat 7ETM + satellite image).

The anticline is distinctly expressed in the Miocene deposits, it is characterized by a narrow sharply asymmetric transverse profile with steep (40°) southeastern and gently sloping northwestern flanks and, probably, is a frontal fold over a “blind”, non-exposed fault (expressed by a lineament).

On the satellite images and topographic maps, the subsalt arch of the Gadzhak uplift is characterized by the practical absence (very small number) of arc decoding elements - satellite images with their increased density on the periphery of the uplift. Such a distribution of satellite images, as the experience of Cosmo geological studies shows, is typical for large tectonic blocks with a relatively weak mobility

of the central parts and an activated periphery. According to drilling and seismic data, the highest subsalt part of the Gajak uplift is located near the southeastern border (somewhat displaced due to the asymmetric structure to the northwest of the post-salt anticline). Along the fault (lineament) controlling from the southwest, the subsalt arch of the uplift extends in the northwest direction, where, in the area of well № 14, it is undercut by a transverse northeastern fault with the formation of a dome in the lower Upper Jurassic anhydrites (Figure 5).



**Figure 5.** a) Digital elevation model; b) Structural map for the roof of the XV horizon; c) Geological profile along the line I-I.

Areal new tectonic activation was noted within all border parts of the Gajak uplift, except for the southeastern, pronounced suprasalt anticline. The western peripheral part of the uplift is most active. Here, in the submeridional block, sandwiched between two lineaments (the eastern one coincides with the fault according to seismic prospecting), three local anticlinal lines are outlined (two of them – Ogjar and Rabat were established by remote sensing methods, the Beshirkak anticline – by seismic prospecting). The named structures form a single submeridional activated anticlinal zone, which is considered as an independent oil and gas promising area [1].

Within the northeastern peripheral part of the uplift, three local subsalt anticlines are also outlined according to the typical set of interpretation features. Two of them – Dashchigaz and Namalum – were established by seismic prospecting, the supposed Urtabuz anticline located between them was outlined for the first time. All folds are characterized by large sizes (judging by the parameters of the controlling

lineament cells), northeastern strike and stepped plunge in the northwest direction. The prospects of this anticlinal zone are determined, in our opinion, by the presence (and amplitude) of a fault between the zone and the central part of the uplift from the area of well № 18 to the northwest (the corresponding lineament is clearly fixed on the satellite images and topographic base, but the fault has not yet been established by seismic prospecting). In the southwestern part of the Gadzhak uplift, the pre-salt Jurassic deposits, judging by the materials of drilling and seismic prospecting, are the deepest. They are submerged stepwise from well №. 6 – the discoverer of the subsalt gas deposit to the south, to the axis of the Baysun syncline. Here, in the area of well №7, according to the data of the satellite images interpretation and the arc bend of the Say, limiting the uplift from the southwest, a subsalt local anticline – Kazgan is outlined, probably the most deeply submerged of all the uplift structures.

## 5. Conclusion

The main scientific and practical results of a comprehensive geological interpretation of remote sensing materials of the Baysun structural-tectonic zone made it possible to determine the following conclusions:

1. Prospects of oil and gas content of the investigated area are associated, first of all, with large block and swell-like uplifts associated with the relatively shallow bedding of the platform foundation. The most promising in this case are the edge parts facing the adjacent deep deflection.
2. With the help of structural interpretation of satellite images, it is possible with a fairly high degree of reliability to predict the location of local structures, predict the degree of their disturbance (tectonic fracturing), and detect faults separating oil and gas deposits into separate blocks. The results of structural interpretation of satellite images allow not only more definitely and unambiguously tracing the position of faults identified by geophysical data, supplementing information on their position and length, but also highlighting a large number of previously unknown faults, materials about the presence of which, according to geophysical data, can be obtained only with their additional, purposeful reinterpretation.
3. Cosmogeological studies have identified a number of objects that are promising for the detection of structural traps, the identification, preparation and prospecting of which can lead to the discovery of oil and gas accumulations. Correlation links established for each of them, between the geological-geomorphological and deciphered structural-tectonic structure, on the one hand, and the deep geological structure (according to the data of deep drilling, seismic-gravity-magnetic-electrical exploration and other types of research, you -completed in the area), on the other hand, can be used to decipher the deep structure similarly expressed on space materials and other areas of the Boysun structural-tectonic zone.

## 6. References

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- [2] Abdullaev G S, Dolgoplov F G, Bikeyeva L R 2018 Neogene-Quaternary geodynamics of multilevel regmatic systems of inclined and strike-slip faults in lithospheric blocks in Central Asia. Proceedings of the International Scientific Conference “Geophysical Methods for Solving Actual Problems of Modern Seismology” is dedicated to the 150th anniversary of the Tashkent Research Geophysical Observatory (Tashkent) 173-178