PRINCIPLES OF THE RSS-NMR

INNOVATIVE TECHNOLOGY

CLASSIFICATION

DIRECT METHOD OF EXPLORATION AND SURVEY OF DEPOSITS

PHYSICAL EFFECT: NUCLEAR MAGNETIC RESONANCE

APPLICATION OF SPACE IMAGES

1–2 months

Diagnostics of large areas

[UP TO 10 000 SQ.KM AND MORE]

2 months

Exploration and survey of deposits

[1-1000 SQ.KM]

WORK ON SITE

2 months

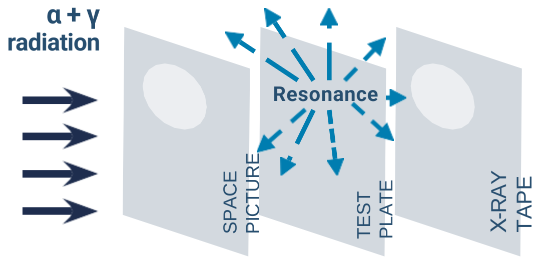
Expedition to the site

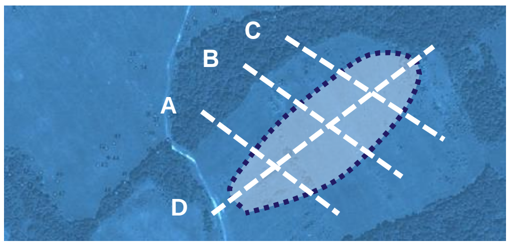
[DEPOSIT AREA]

WE WORK WITH: HYDROCARBONS, UNDERWATER ACCUMULATIONS, OTHER MINERALS IN LARGE AND SMALL TERRITORIES, ON LAND, ON SHELF

THE GENERAL IDEA OF TECHNOLOGY

Preliminary the spectrum of the searched mineral is recorded on the **special test plates**





SPACE IMAGES

Test plates are used as a resonator in radioactive and chemical processing of analogue satellite images of an area captured in the infrared range. The result is a direct visualization of ground boundaries of basins and deposits.

ONSITE EXPEDITION

Point-by-point resonant profiling of the area: clarification of deposit boundaries, obtaining longitudinal and cross sections. Selection of optimum drilling points, refined calculation of expected deposit reserves. Test plates are used for spectral modulation of transmitter radiation.

CAPABILITIES OF THE TECHNOLOGY

TERRITORIAL APPLICABILITY	no limitations (any in-land or shelf area)
TOTAL SIZE OF THE TERRITORY	practically without limitations
SOUNDING DEPTH	0-5 km underground
DETECTABLE MINERALS	water, oil, gas, different metals in ore beds
SUCCESS RATIO	for hydrocarbons and water reserves > 90%
DURATION	typically 2 months
SAFETY	the method is environment-friendly and completely safe for people

«DIRECT» IDENTIFICATION OF MINERALS PROVIDES HIGH EXPLORATION RESULTS OVER A SHORT PERIOD WITH LOW COSTS OF WORK

SERVICES OF INSTITUTE ARE PROVIDED IN THE FOLLOWING FORMAT:

REMOTELY
[4 OPTIONS]

ON SITE
[2 OPTIONS]

The set of services allows solving a variety of tasks

USE OF THE TECHNOLOGY

1 **PROMPT AREA SCANNING**

2 **REMOTE SURVEY OF SITES**

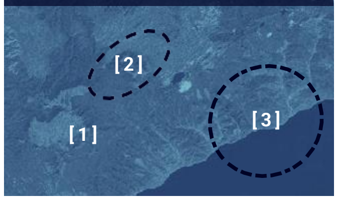
3 **MAPPING OF MINERAL DEPOSITS**

4 **SURVEY OF WELLS**

DIAGNOSTICS

Area of the diagnostic survey

Results obtained in 1-2 months



1 Aquifer
2 Gas deposit
3 Oil field

DIAGNOSIS OF AREAS AND BLOCS IS PERFORMED ON THE AREA UP TO 10,000 SQ. KM AND MORE

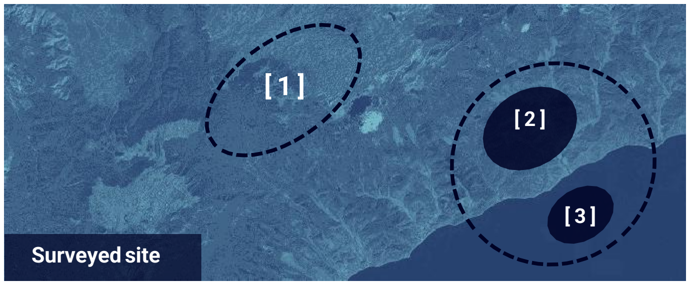
TASKS TO BE SOLVED:

1.Rapid identification of deposits and basins of hydrocarbons on large areas, aquifers and other minerals upon request.

2.Determination of ground boundaries of deposits, estimation of the number of horizons and their possible depths.

DIAGNOSIS ALLOWS QUICK ASSESSING OF THE DEPOSIT RESERVES PROSPECTS ON LARGE AREAS

REMOTE SURVEY OF SITES



1 Natural gas deposit
2 , [3] Oil deposits

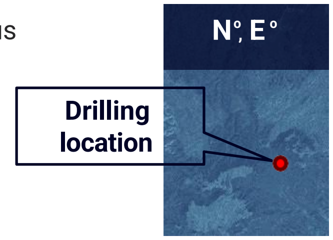
TASKS TO BE SOLVED:

1. Identification, localization and getting ground boundaries of deposits.
2. Determination of the number of deposit horizons.
3. Determination of the horizon depths.
4. Determination of horizon capacities.
5. Assessment of reservoir formations.
6. Calculation of estimated deposit reserves.

RESULTS ARE OBTAINED IN 2 MONTHS

MAP OF MINERALS

Mapping of deposits of various minerals on large land and offshore areas.



REMOTE SURVEY OF DRILLS

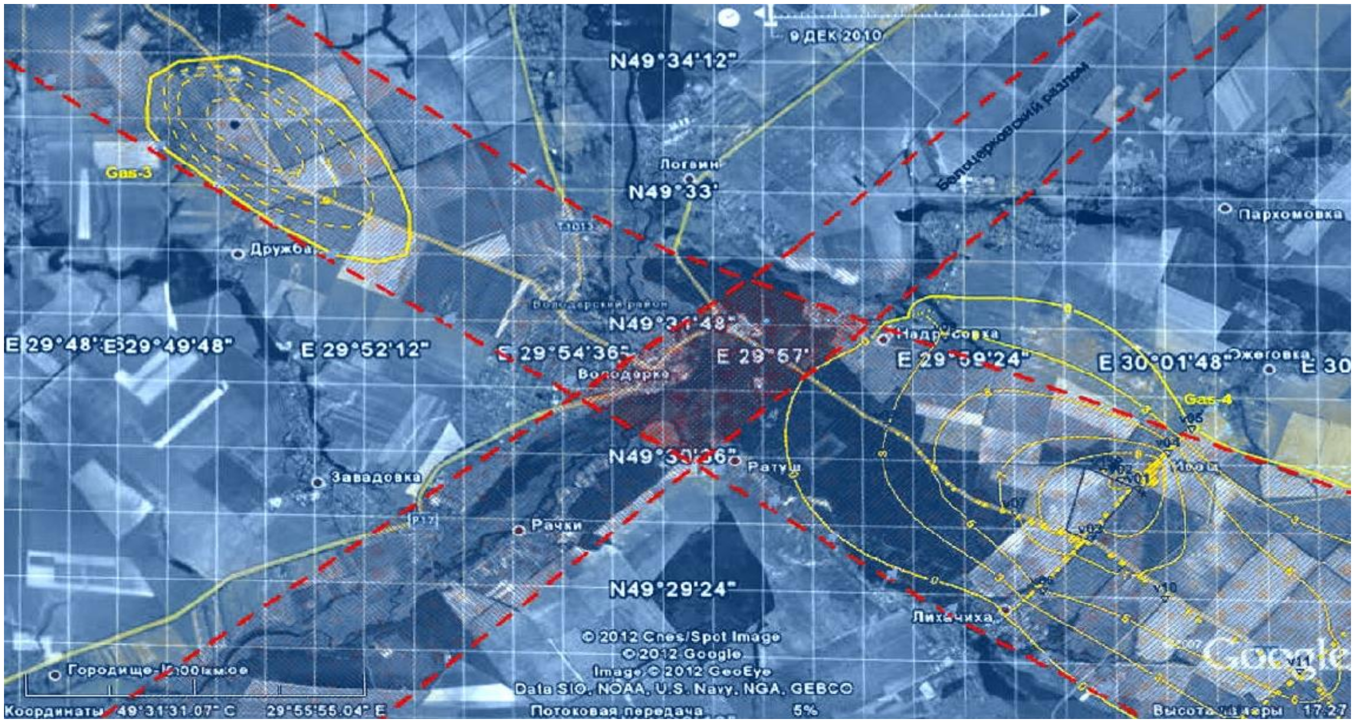
SURVEY RESULTS:

—presence or absence of the desired mineral in a drilling point (or nearby), if «yes», we define:
— ground boundaries of a deposit, the number of horizons, the depth and the expected capacity.

THE RESULT IS ACHIEVED IN 1 MONTH

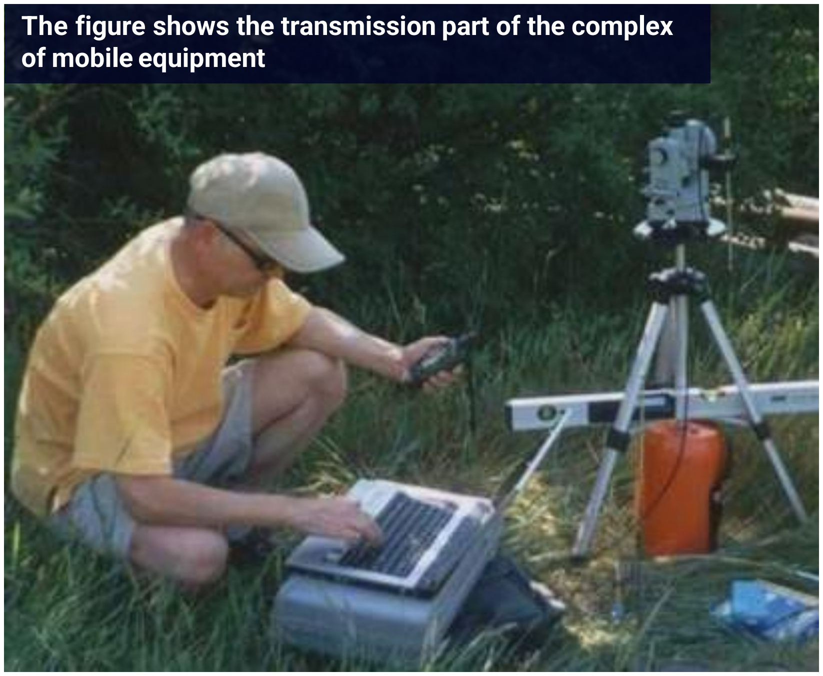
EXAMPLE OF REMOTE SENSING AREA

[TOTAL SITE AREA IS 500 SQ. KM]



TWO DEPOSITS WERE FOUND IN COMPLEX NATURAL GAS FORMATIONS. SEEN AS TWO FAULT ZONES (RED) AND PROSPECTIVE SITES FOR DRILLING.

HOW WE WORK ON SITE



The figure shows the transmission part of the complex of mobile equipment

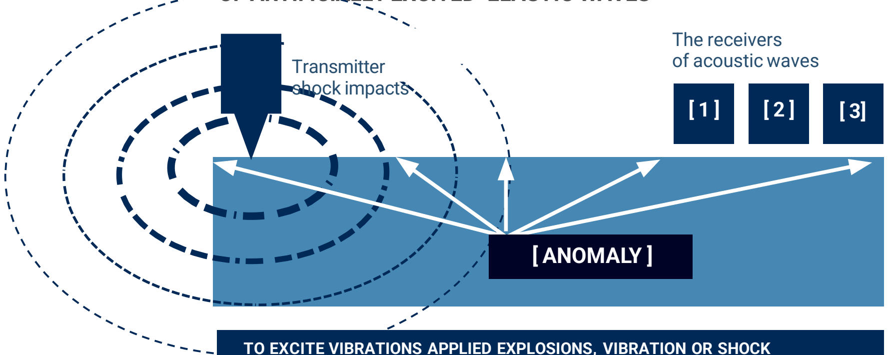
DURING THE EXPEDITION SPECIFIED PARAMETERS DEPOSITS, DETERMINED BY THE EFFECTIVE POWER HORIZONS. SELECTS THE OPTIMUM DRILLING LOCATION. FOR THESE POINTS, WE ARE BUILDING A DEEP COLUMN. THE DATA OBTAINED
ARE SPECIFYING RECOVERABLE RESERVES

WORK ON THE GROUND IS ABSOLUTELY HARMLESS TO HUMANS AND THE ENVIRONMENT

TECHNOLOGIES COMPARAISON

[SEISMOGRAPHY]

INVESTIGATION OF THE EARTH'S CRUST, BASEDON THE STUDY
OF ARTIFICIALLY EXCITED ELASTIC WAVES

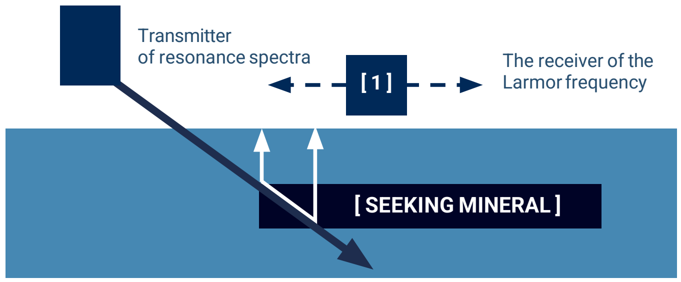


TO EXCITE VIBRATIONS APPLIED EXPLOSIONS, VIBRATION OR SHOCK EFFECT ON THE ROCKS

EFFECTIVENESS	about 30%
RESTRICTIONS	on the character terrain
COST OF THE WORK	the relatively high cost of the work
DURATION	the long duration of work and data processing
ENVIRONMENT	unfavorable to the environment

[RESONANCE METHOD]

STUDIES OF MINERAL DEPOSITS BASEDON THE EXCITATION
OF THE DESIRED MATERIALOF NUCLEAR MAGNETIC
RESONANCE

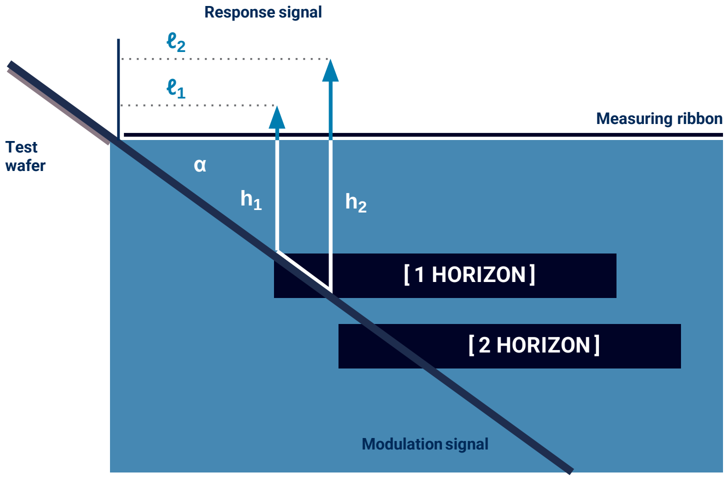


TO EXCITE RESONANCE APPLIES THE SIGNAL SPECTRUM CORRESPONDING TO THE DESIRED SUBSTANCES

EFFECTIVENESS	90%
RESTRICTIONS	no restrictions on the character terrain
COST OF THE WORK	the relatively low cost of the work
DURATION	the short duration of work and data processing
ENVIRONMENT	It has no effect on humans and the environment

FEATURES OF POINT-BY-POINT RESONANT PROFILING OF THE AREA

[DIAGRAM OF MEASUREMENT OF DEPOSIT PARAMETERS]



In measuring point the modulated laser beam is directed towards deposit under **α angle**. Modulated signal spreads under ground from test wafer.

Operator moves along the measuring ribbon with receiver. Response signal is registered at distance from ℓ_1 to ℓ_2.

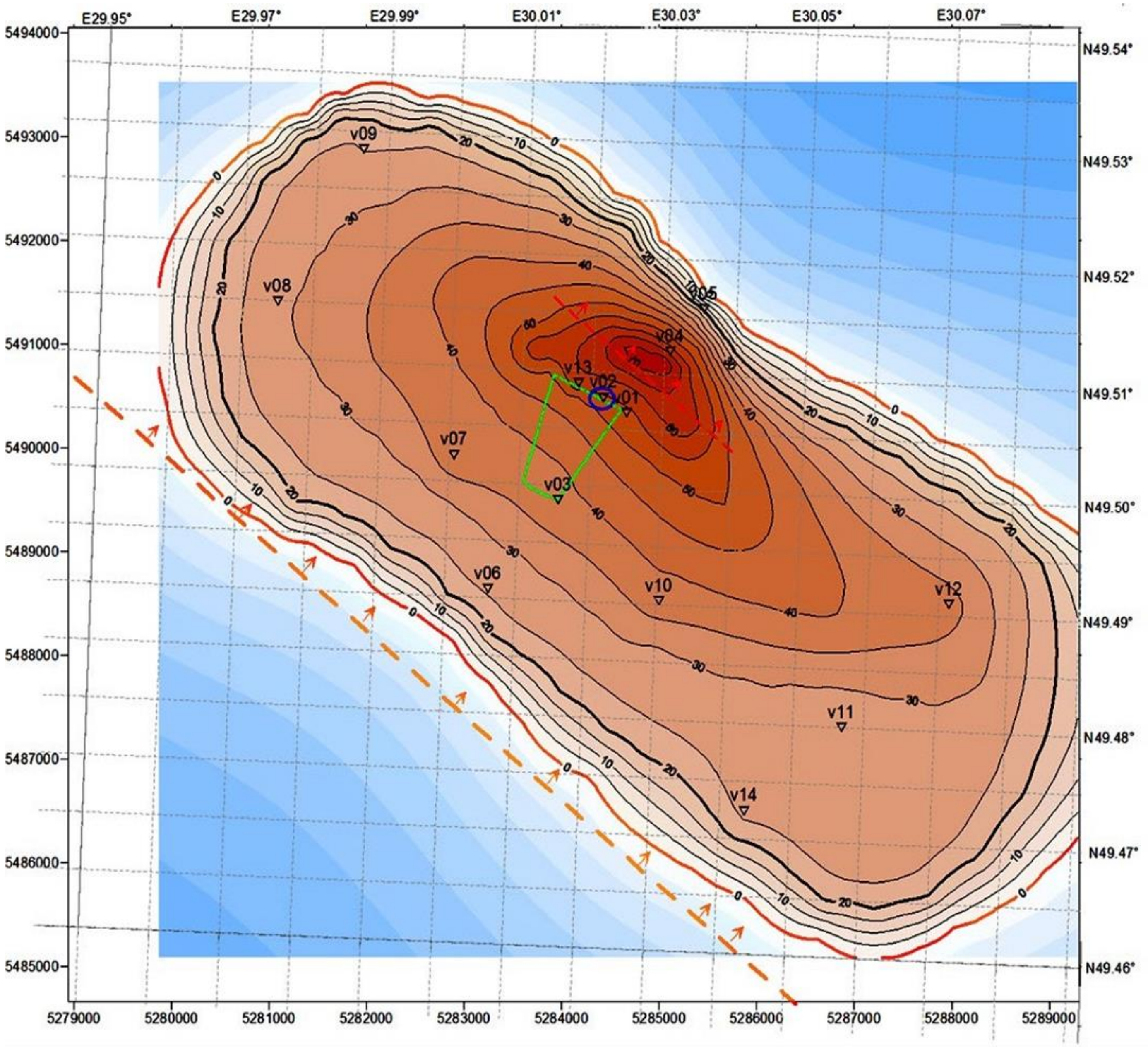
Occurrence depths of a horizon are calculated with the help of the following formulae:

$h_1 = \ell_1 \times \text{tg}\ \alpha$　　$h_2 = \ell_2 \times \text{tg}\ \alpha$.

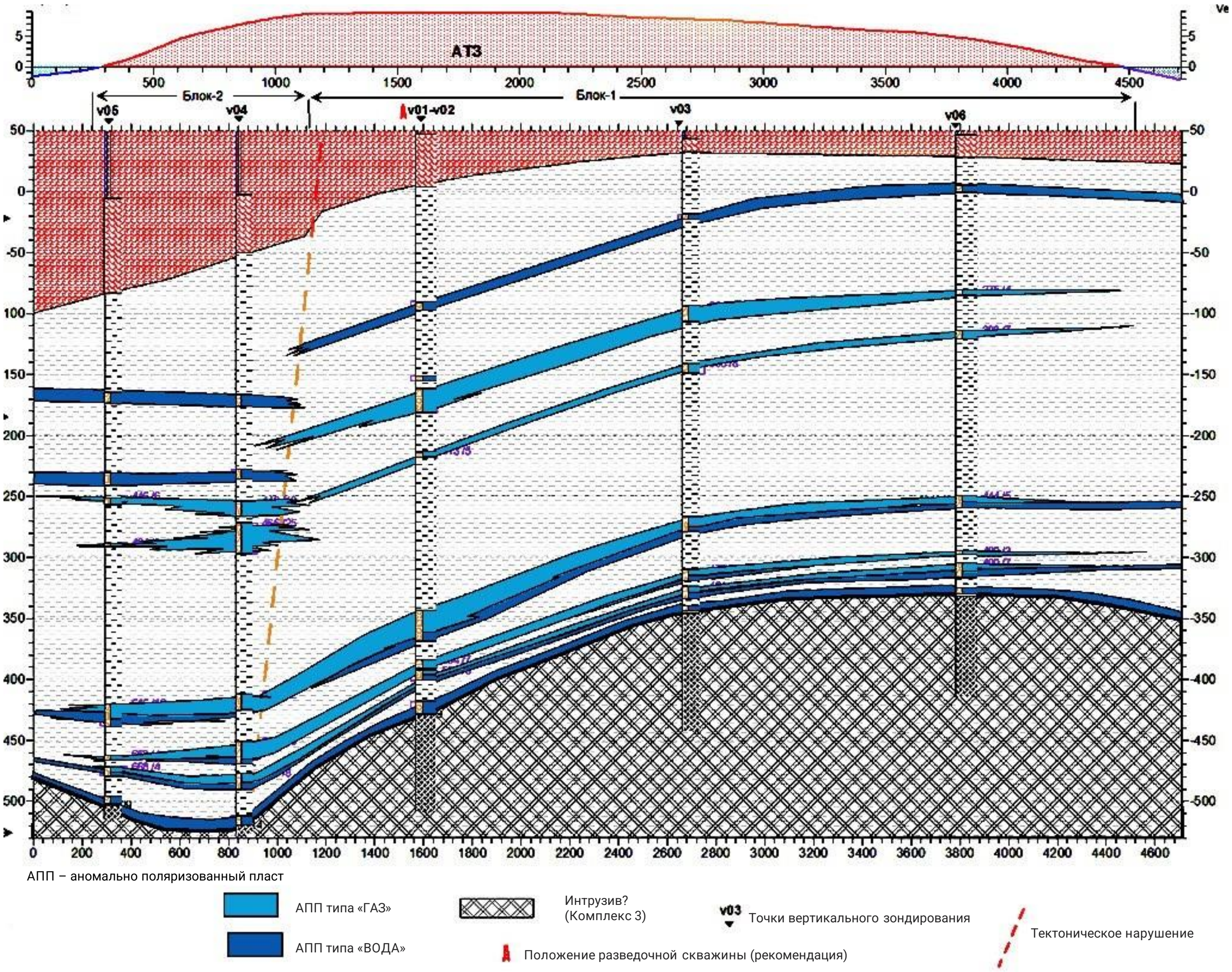
Horizon thickness: $\Delta h = h_2 - h_1 = (\ell_2 - \ell_1) \times \text{tg}\ \alpha$

SURVEY EXAMPLE: NATURAL GAS

[GROUND BOUNDARIES OF A DEPOSIT
]

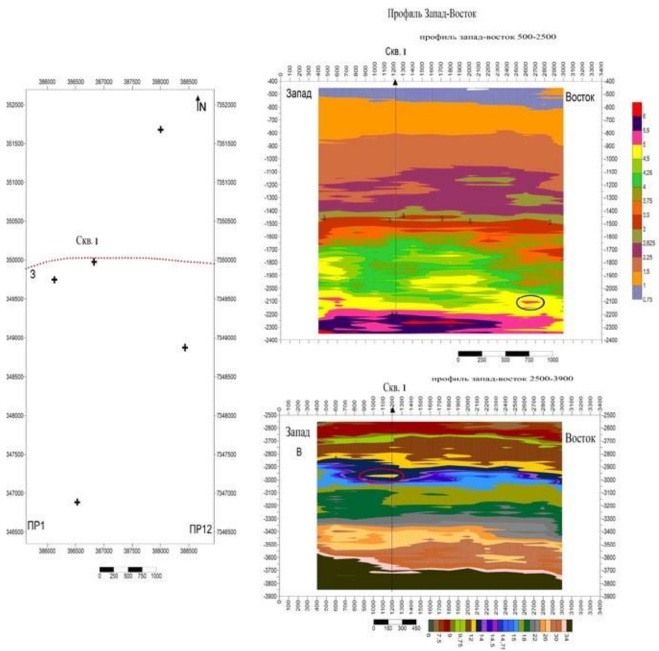


Longitudinal section of a deposit

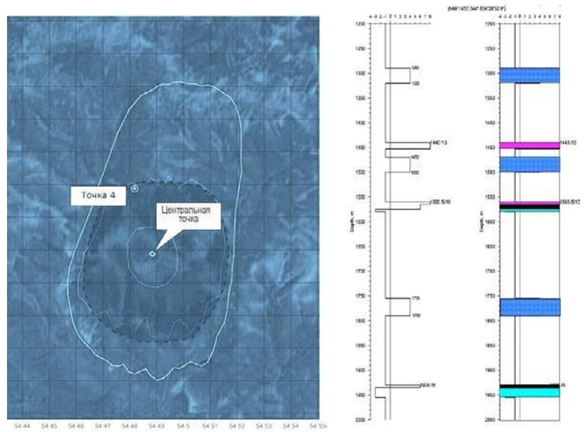


EXAMPLE OF WORK PERFORMED

[KOMI REPUBLIC OF THE RUSSIAN FEDERATION]



VERTICAL SECTION OF THE ELECTROMAGNETIC FIELD BY THE WEST-EAST PROFILE



DETAILED REMOTE SPACE GEOLOGICAL AND FIELD GEOPHYSICAL SURVEYS USING THE NMR EQUIPMENT IN KOMI REPUBLIC OF THE RUSSIAN FEDERATION IN 2015

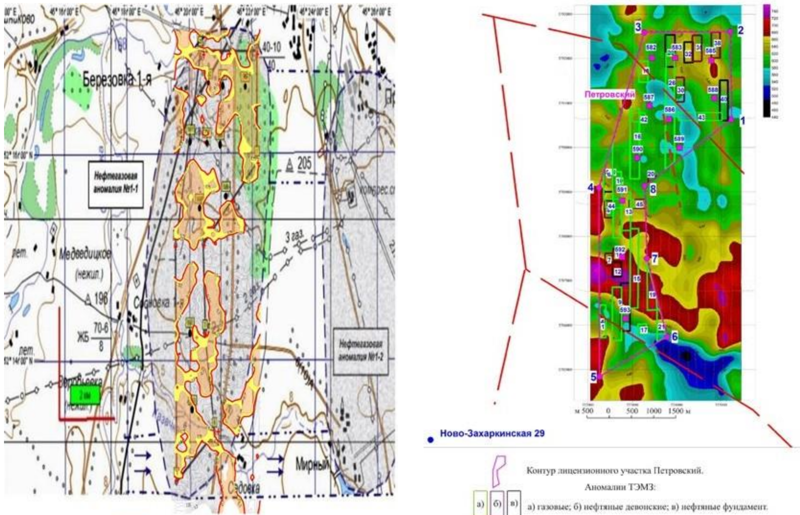
Coincidence — 97.3% based on results of drilling of an exploration well №1

Well №2 — drilling is scheduled for 2016

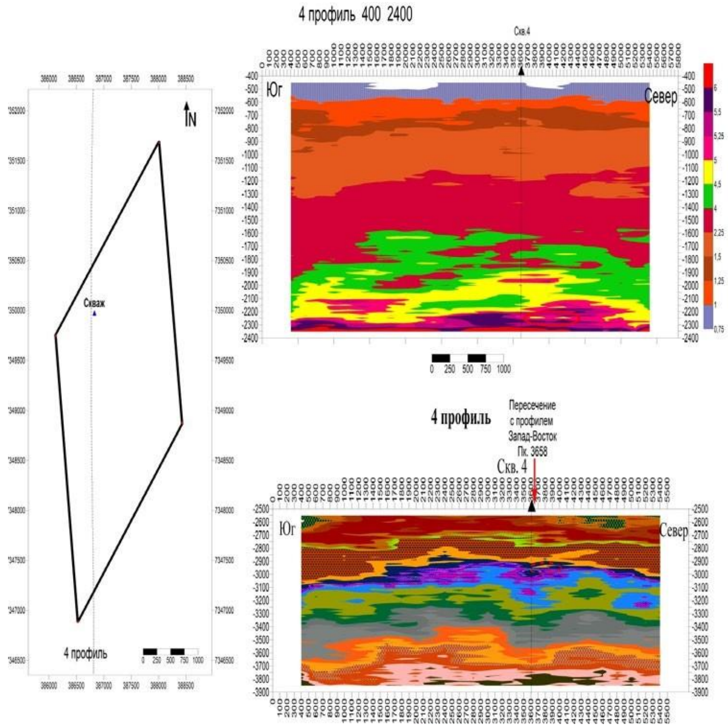
EXAMPLE OF WORK PERFORMED

[SARATOV REGION OF THE RUSSIAN FEDERATION]

Boundaries of oil and gas anomalies with measuring points of depth



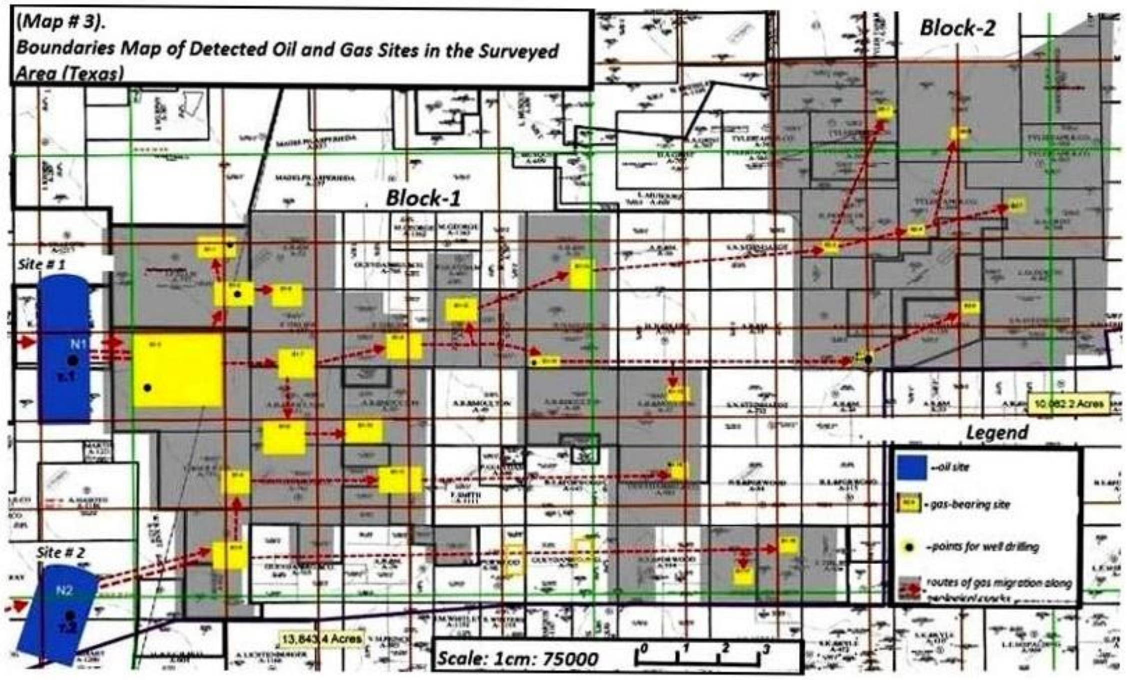
DETAILED REMOTE SPACE GEOLOGICAL AND FIELD GEOPHYSICAL SURVEYS USING THE NMR EQUIPMENT IN SARATOV REGION OF THE RUSSIAN FEDERATION IN 2016



VERTICAL SECTION OF ELECTROMAGNETIC FIELD BY PROFILE 4

EXAMPLE OF WORK PERFORMED

[PROJECT FOR SHALE GAS IN TEXAS, UNITED STATES]



The figure shows the contours of the ground 25 identified shale gas drilling points on the largest sites, migration routes of gas along faults, as well as the contours of the west identified two oil deposits.

The data on the number of horizons (6), power and depth of their occurrence, as well as gas pressure levels (30–50 amt).

UNDERGROUND WATER PROJECTS

Country	Area remote	Coordinate survey that drilling	The depth, m	Type of water
			Our data / drilling results	Our data / drilling results
Mauritania, city of Atar	2500 sq. km.	N 20032’ E 13002’30”	130 ÷ 150 / 125 ÷ 150	Fresh / fresh
Mongolia, Gobi Desert	1600 sq. km.	N 44001’40” E 108029’00”	270 ÷ 320 / 275 ÷ 320	Fresh / fresh
Cyprus, cityof Limassol	400 sq. km.	N 34042’00” E 33001’20”	180 ÷ 200 / 195 ÷ 205	Fresh / fresh
Ukraine, Sevastopol, Simferopol	1600 sq. km.	more than 100	From 50 to 950 / Error 1÷10%	Fresh / fresh (two errors)

PUBLICATIONS BY OUR SCIENTISTS ON THIS SUBJECT

1.G.A. Bielawski, NI Kovalev. New technologies in remote environmental monitoring of underground and underwater objects // «Environment and Resources», vol. Number 9, Kiev, 2004., P.7.

2.N.I. Kovalev, etc. Remote defining the contours of underground fresh water in the Gobi Desert in Mongolia / Scientific report «Gobi» SNUNEI, Sevastopol, 2008., P.65.

3. N.I. Kovalev, etc. Investigation of the mechanism of formation of underground fresh water near the magma chambers extinguished volcanoes. International Conference «Space technologies in geophysics» // C-P, Russia, 2013.

4. Kudric I.D, Kovalev N.I., Bielawski S.G. Environmental monitoring. / / Cherkassky CSTEI, 2013. P.258.

COMPARATIVE EFFICIENCY FOR LARGE TERRITORIES

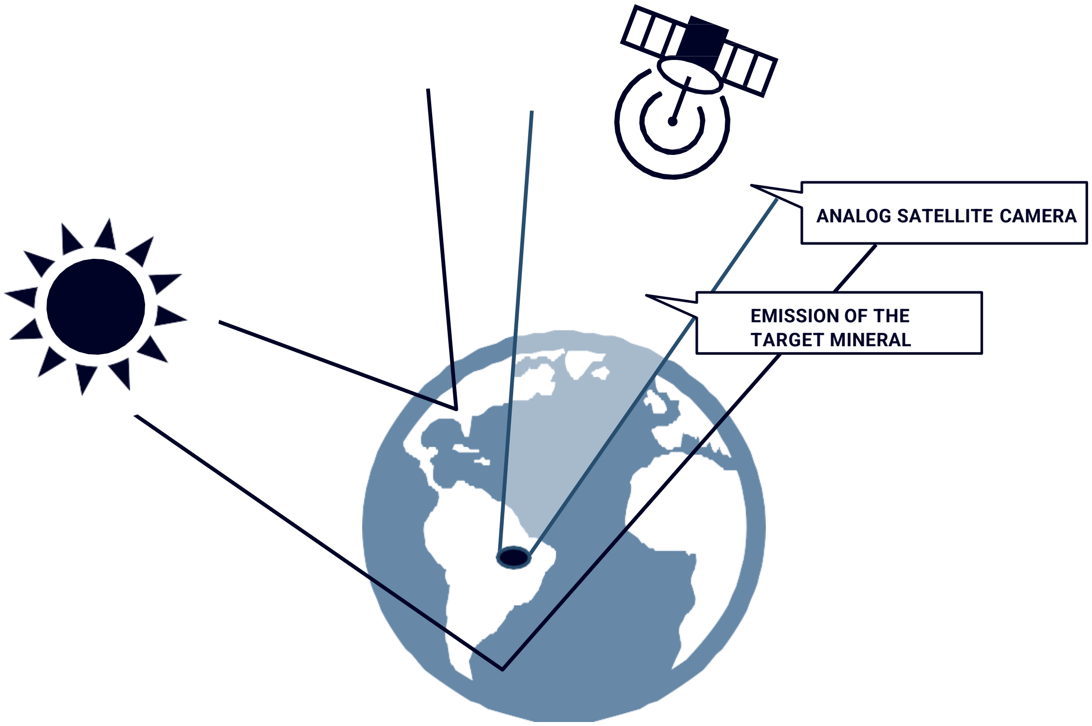
Traditional methods	Space survey Geological survey Geophysical survey Searching boring	~ 30 %	3–5 years	6 (From data of Russian State Institute of Oil and Gas)
Innovation technology	Radiation-chemical treatment of spaces pictures Nuclear-magnetic resonance sounding of a deposit on-site	more than 90 %	2 months 2 months	1

[COMPARATIVE CHARACTERISTICS WITH 3D SEISMOGRAPHY]

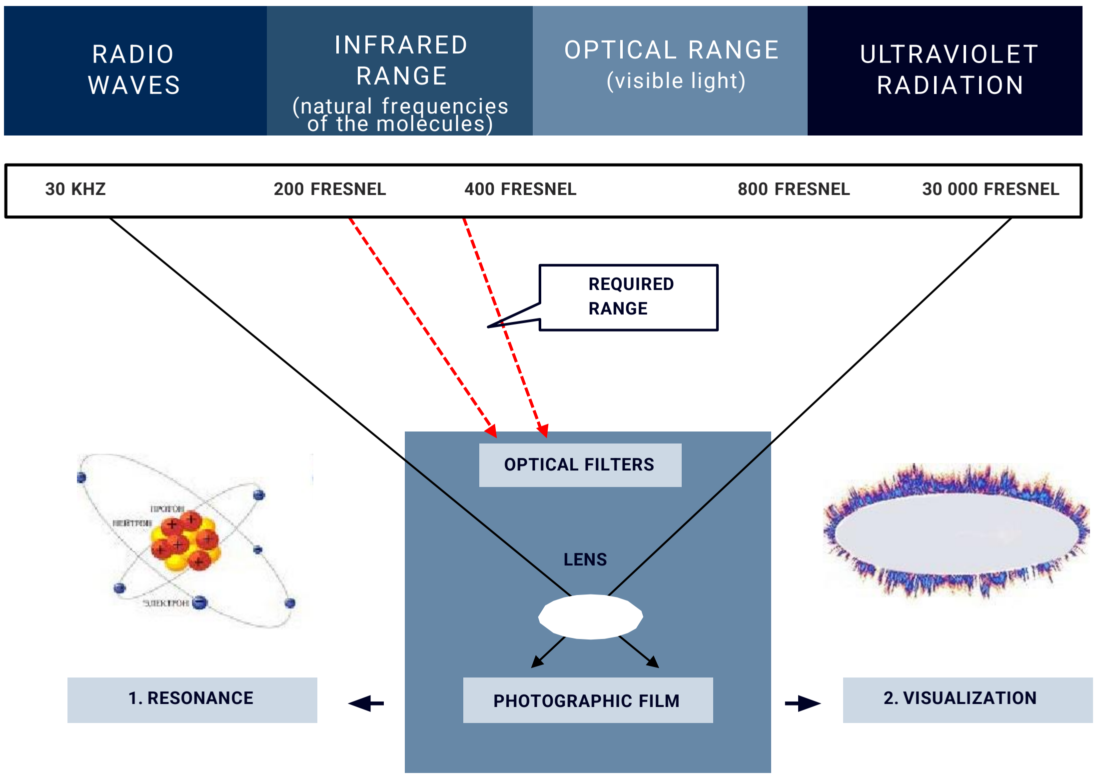
			“IT”
			+
1	Topographical binding	**+ (anomalies)**	**+**
2	Construction of 3D models of objects	**+ (anomalies)**	**+**
3	Search of unstructured traps of oil and gas	–	**+**
4	Detection of gas ‘caps’ in oil horizons	–	**+**
5	Definition of gas pressure in gas ‘caps’	–	**+**
6	Definition of presence of oil mobility	–	
7	Detection of water horizons over oil and gas deposits	–	**+**

REMOTE EXPLORATION OF AREAS USING SATELLITE IMAGERY

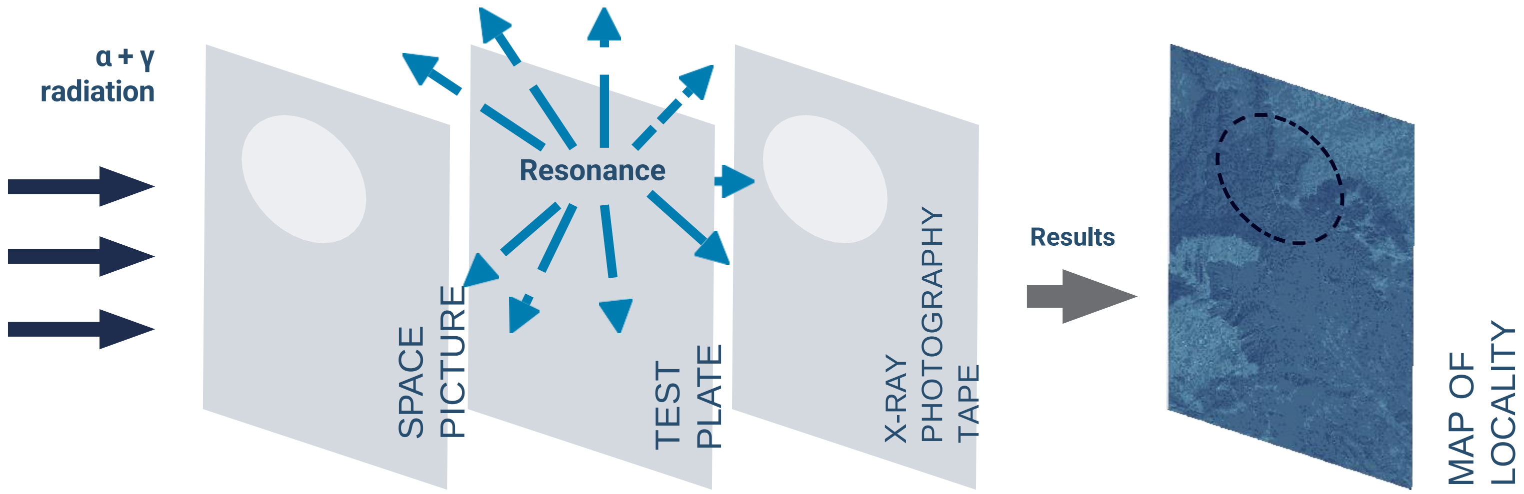
[RADIATION-CHEMICAL TREATMENT OF ANALOGUE AEROSPACE PHOTOGRAPHS]



RADIATION-CHEMICAL TREATMENT OF ANALOGUE AEROSPACE PHOTOGRAPHS



HOW IT IS DONE



PACKED IN «SANDWICH» AND PLACED INTO THE REACTOR ZONE IR-100

RADIATION-CHEMICAL TREATMENT OF ANALOGUE AEROSPACE PHOTOGRAPHS

VISUALIZATION OF LATENT IMAGE WITH KIRLIAN EFFECT

LIST OF TECHNOLOGICAL OPERATIONS

OPERATING SEQUENCE

2 weeks

1. PREPARATORY WORKS
Order and obtaining of aerospace photographs of the investigated territory.
Order and obtaining of ultra-pure chemical reagents.
Laboratory manufacture of test gel-wafers.
Recording of electromagnetic spectrum of the sought-for substance on test wafers.

2 weeks

2. OBJECT IDENTIFICATION
Radiative processing of aerospace photographs on research nuclear reactor with test wafers of the sought-for substance and sensitive X-ray film.
Chemical processing of negatives that have undergone radiative and energoinformational impact in the nuclear reactor.

1 week

3. CONTOUR OBJECT DECIPHERING
Visualization of object contours and also incoming and outgoing torrents with the help of Kirlian-camera.
Obtaining of computer image with the help of digital camera connected to Kirlian-camera.

1 week

4. PHOTOGRAMMETRIC CALIBRATION
Photogrammetric calibration of computer image of the object (geographic connection of the image's points and the area).

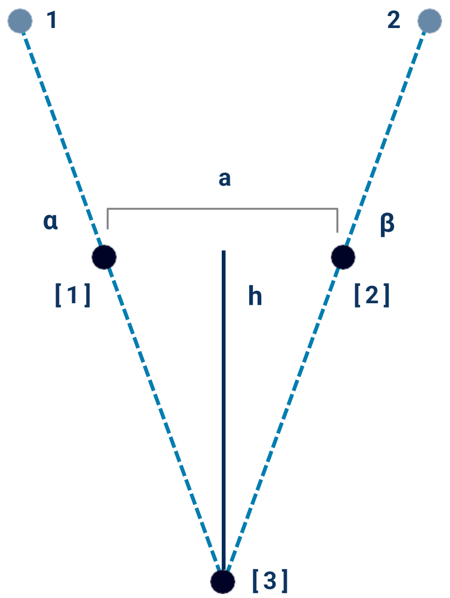
5. OBJECT'S FIXATION
Definition of its size, form and location on the area according to the photograph.

2 weeks

6. ANALYTICAL DATA PROCESSING
Analytical data processing obtainment of coordinates of beds and preliminary calculation of supplies.

7. PREPARATION OF REPORT
and providing the Customer with it.

THE PROCEDURE FOR MEASURING THE DEPTH OF OCCURRENCE OF DEPOSITS USING ANALOG SATELLITE IMAGES



1.Use space images the investigated area obtained at different elevation angles **α** and **β** from the satellites **1** and **2.** Obtain ground mapping point **3** in two differ- ent positions, **«1»** for the first satellite and **«2»** for the second.

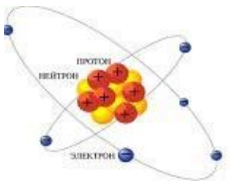
2.We calculate coordinates of points **1** and **2**, calculated by different images.

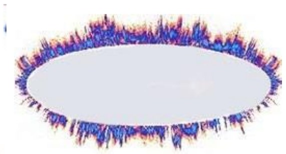
3.Determine the amount of displacement «and» between them on the ground.

4. In the triangle **1-2-3** side a and the adjacent interior angles **α** and **β** are known. Such a triangle is called a solution. After the evaluation is determined by the depth of the deposit **h**.

TECHNICAL IMPLEMENTATION

RADIOACTIVE AND CHEMICAL TREATMENT OF ANALOG SATELLITE IMAGES OF SURVEYED AREAS





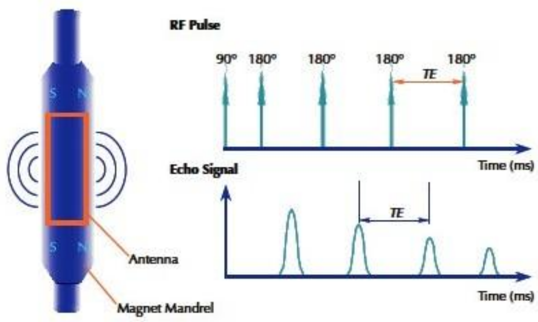
PHYSICAL EFFECTS USED

- Nuclear magnetic resonance
- Energy transfer of test minerals characteristics to test plates
- Chemical and electromagnetic (Kirlian effect) imaging of objects

EQUIPMENT AND MATERIALS

- Special chemical laboratory
- Isotropic source of α and γ radiation
- Space images of the surveyed area in the deep infrared range
- High-purity chemicals
- Highly sensitive X-ray film

NMR METHODS IN GEOPHYSICS



[MAGNETIC LOGGING METHOD]

Companies HALLIBURTON and SCHLUMBERGER

+ Direct measurement of T1 parameter for identification of fluids, porosity and permeability, regardless of lithology

– Small radius of the survey, powerful magnets, powerful transmitter

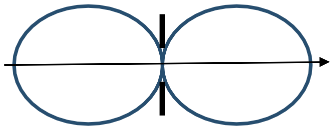
r =0,05–0,2m; f =0,6–1,2 MHz; B_0=0,1–3T; P =50–300W

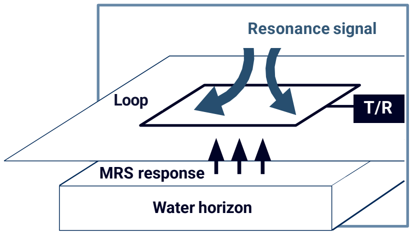
[METHOD OF MAGNETIC RESONANCE SENSING, MRS]

IRIS INSTRUMENTS and others

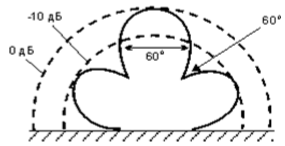
+ Direct measurement of T2 parameter for identification of water horizons, depth and porosity of collectors

– Shallow depth of survey (up to 150 m), a powerful transmitter (4000 V, 600 A pulse)





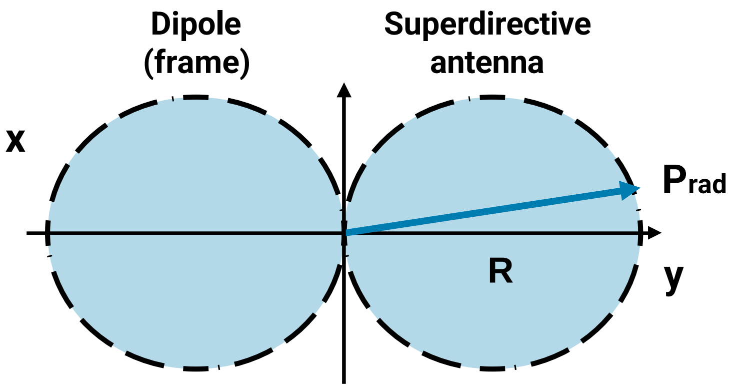
Disadvantages are caused by poor antenna directivity:



LOW HORIZONTAL FRAME ANTENNA

INCREASE OF THE EMISSION POWER

[USE OF THE SUPERDIRECTIVE ANTENNA]



ANTENNA EMISSION POWER:

$P_{rad} = \eta_A \times G_A \times R_{trans}$
(where **x Rtrans** -transmitter power,
η_A — efficiency of the antenna,
G_A — antenna gain).
For Dipole GA ~ 4,
for a directive antenna:
$G_A = S_1/S_A = 4\pi \times R^2 / S_A$
(where **S_A** — the effective area of antenna).
When **$R = 1m$** и **$S_A = 10^{-6}\ m^2$**, we get the superdirectivity antenna gain by power
$G_A = 4\pi \times 10^6 \sim 12 \times 10^6$

[IMPROVED SURVEY RELIABILITY]

The above systems use a sinusoidal signal of resonance. However, oil comprises 1,000 elements, so in order to maximize identification of the target mineral, it is necessary to cause a resonance in all molecules of the target substance.

THE MAIN IDEA OF THE INNOVATIVE METHOD IS TO PERFORM THE POINT-BY-POINT PROBING OF AN AREA WITH A FREQUENCY SPECTRUM, CAUSING A RESONANCE IN THE TARGET MATERIAL

REDUCTION OF RADIO- WAVE ABSORPTION IN THE GROUND

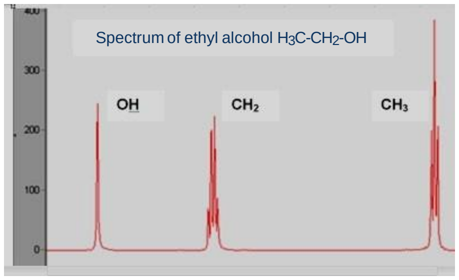
In order to reach this goal we use the effect of 'chemical shift' in NMR.

If it were possible to form spectrum of oil frequencies and use this signal for its actuation, we would be able to considerably reduce absorption of signal energy in other substances.

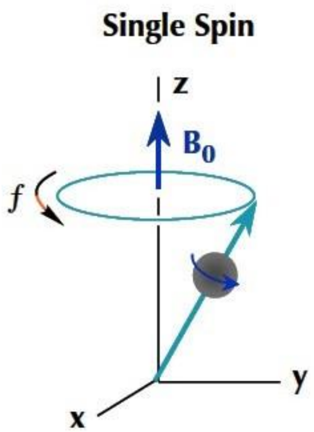
Since oil is a mixture of molecules of complex hydrocarbons (in any oil sample there are more than thousand of various compoundings) it is almost impossible to generate such complex vibrations with the help of traditional methods.

WE DECIDED TO SOLVE THIS TASK BY RECORDING SPECTRA OF SAMPLE SIGNALS ONTO SPECIAL TEST WAFERS AND USE THEM FOR MODULATION OF FREQUENCY OF THE MASTER GENERATOR

Proton in constant magnetic field has a fixed absorption frequency $F = \gamma B_0 / 2\pi$



Grouping of atoms into molecules causes complex absorption spectrum, which is an 'individual address' of each molecule

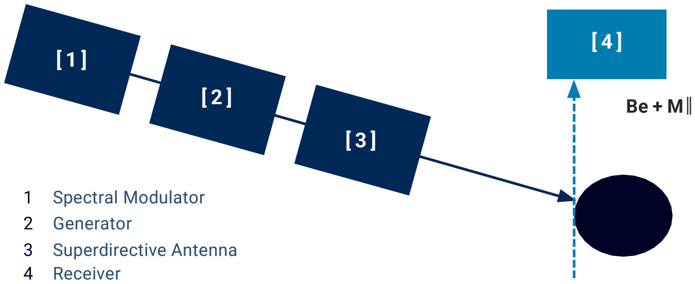


$$f = \frac{\gamma}{2\pi} B_0$$

RSS NMR
the simple way of exploration
GROUP POISK
SEVASTOPOL STATE UNIVERSITY

IMPLEMENTATION

[DIAGRAM OF RECEPTION OF RESONANCE SIGNAL FROM DEPOSIT]



1 Spectral Modulator
2 Generator
3 Superdirective Antenna
4 Receiver

For resonance actuation of oil molecules in a deposit and registration of response signal we use a transmitter containing:
— spectral modulator 1,
— master generator 2,
— superdirective antenna 3, as well as
— superregenerative receiver 4.

Characteristics of various oil types are recorded from samples onto test wafers. Test wafers as spectrum carriers are used for modulation of semiconductive laser (positive decision on international application PCT/UA2011/000033).

Laser aiming device

AS INTEGRATED WITH ANTENNA HIGH FREQUENCY GENERATOR WE USE RED GALLIUM-ARSENIDE LASER:
PRAD = 0,2 W,
BEAM DIAMETER = 1,1MM,
$G_A = 12 \times 10^6$
RELATIVE TO POINT-LIGHT ISOTROPE EMITTER

RSS NMR

THE SIMPLE WAY OF EXPLORATION

By Fands-LLC

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