# Remote Sensing (RS) with Nuclear Magnetic Resonance (NMR) for Hydrocarbons, Minerals and Water Resources Exploration

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# Introduction

- POISK Group offering a time & cost effective solution to remodel the ways and means of petroleum exploration.

- By ingenious remote sensing expertise plus corroborating field works derived from the Nuclear Magnetic Resonance (NMR) theory, commercially relevant anomalies are identified, delineated and geologically substantiated.

- Pre-knowledge on economic feasibility of acreage is provided; recommendation on best area for targeted seismic (if so pursued); the identification and geological validation of best spot for appraisal act is provided as a result of RS-NMR studies.

- The application of three integrated disciplines of patented remote sensing acumen, scientifically vindicated NMR field works and the ultimate G&G authentication of the findings, exercises a strong and innovative toolkit that is as disruptive as it is efficient.

# Team: An established team of leaders in their field



V . G O K H -  THE MEMBER OF THE RUSSIAN ACADEMY OF NATURAL SCIENCES, THE AUTHOR OF THE GEOHOLOGRAPHY METHOD

N . K O V A L Y O V -  D R., PROF. OF THE SEVASTOPOL NATIONAL UNIVERSITY OF NUCLEAR ENERGY AND INDUSTRY, THE AUTHOR OF THE GEOHOLOGRAPHY METHOD

Dr. Andrey Sergeev
Geologist

N .  K O V A L Y O V

A . K A R P E N K O - D R., PROF. OF THE NATIONAL UNIVERSITY T.SHEVCHENKO, EXPER FIELD OF OIL AND GAS SEARCH

I . K O T E L J A N E C
manager of the project;
graduate economist

**Vipul Sahu**
Managing Director

M.Tech in Applied Geophysics from IIT Roorkee. 18+ years experience in Land/Marine 2D/3D seismic data acquisition & processing. Have worked with NGRI, Reliance, Essar Oil and Asian Oilfield.

**Subhasis Sett**
Director - Business Development

MBA from Henley Business School London and M.Tech in Applied Geophysics from IIT ISM Dhanbad. 18+ years experience. Have worked with Reliance Industries Ltd. in Seismic operations.

POISK Group is a representative of the Sevastopol State University, an association of 11 institutes and more than 12 laboratories. Have executed more than 350 projects with NMR-RS technology.

Wave Geo-services is a Project Management company, providing land/marine seismic data acquisition, processing and interpretation services in India and SE Asia.

# Overview of the Technology

- The innovative technology of remote search for hidden minerals is based on traditional and proprietary methods of **remote sensing of the Earth and special NMR equipment of POISK Group.**

- A key feature of NMR is that the resonance frequency of a particular substance is directly proportional to the strength of the applied magnetic field. It is exploited in imaging techniques; if a sample is placed in a magnetic field then the resonance frequencies of the sample's nuclei depend on where in the field they are located.

- Radio-frequency magnetic fields penetrate both soft and hard rock allowing higher resolution anomalies mapping and can easily be used with a boat, plane, helicopter  or truck for exploration.

- Remote geoholographic is created from instrumental set (stationary and field equipment) for remote search and contour plots of hidden mineral resources (oil, gas, gas condensate, and ore deposits), and accumulations of drinking water, and geothermal, as well as remote determination of important geological characteristics of their bedding to a depth of  6000m.
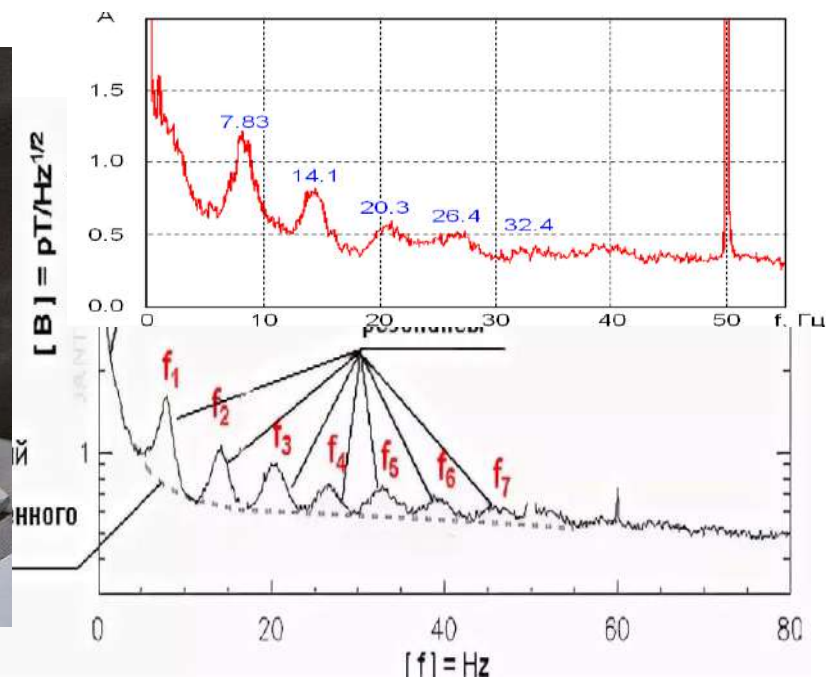
# How it works

| STEP-1<br>Sampling + Data Base | STEP-2<br>Remote Sensing + Data Processing | STEP-3<br>Field Survey |
|---|---|---|
| Analysing the Oil/Gas samples from the nearby field (same play type). | Satellite survey of the interest area and imaging of the analogue photographs | Additional examination of the identified anomalies using field equipment |
| Recording the frequency spectrum of the reference elements present in the sample | Processing images with ingenious nanogels and enhancement in a small-size Nuclear reactor | Field survey using special NMR equipment of the POISK group |
| Lab testing of samples using special POISK equipment | Identify boundaries of hydrocarbon accumulation by processing digital and analog satellite images taken in various frequency ranges of the visible ultraviolet and IR spectra. | Plotting the contours of anomalies associated with petroleum accumulations on maps of the survey area. Generating geological sections with depths of hydrocarbon accumulations |

# Step I – Sampling + Data base

1. Collect and analyze oil samples from nearby fields (same play),

2. Identify reference elements in the samples,

3. Record frequency spectrum of the reference elements,

4. Save the reference element's data base for further hydrocarbon studies

Certain elements (e.g. V, Ni, Cu, Fe, Mn, Mo, Cr etc) are distinguished in oil composition, which are the main markers ("reference elements") in the identification of oil. Each element has its own (inherent) nuclei oscillation frequency.

# Step I – Sampling + Data base

**The study sample :**
1) Neutron activation method
2) Atomic - absorption (spectrophotometer "Saturn" )
3) RENGO-fluorescent methods

2

1 Samples of samples: hydrocarbons, ores, rocks - the water

3 The choice of reference element

4 Spectra were recorded on the reference elements "test matrix"

*spectrum of Oil*

*spectrum of Coal*

5 Laboratory testing of samples with identification of specimens using equipment complex «Search»

6 **Result**
Data bank of recognition spectra for remote identification of deposit types

WGS

## Sample Analysis Process

- The presence of rare earth metals, especially tungsten and titanium (in micro-quantity) are determined in the oil sample. According to their ratio, oil origin can be determined, that is, one may find out, for example, oil is from which country. Same approach is implemented in the NMR survey, i.e. NMR spectra of these elements are recognizable when we search for oil accumulations.

- In oil samples, the composition of other metals is analyzed, the content of which differs significantly from the rest of the NMR spectra. They can also be used as additional diagnostic factors of oil in a particular region, i.e. they are the so-called "test" search matrices.

- Integral electromagnetic spectra (information and measurement spectra) are recorded from oil samples by exciting metal atoms when oil samples are introduced into the "atomization furnace" (temperature = 2500 °C) using special spectral equipment which is part of the "Poisk" facilities complex. Thus, we record the so-called working search diagnostic matrices.

# Step II – RS + Data processing

1. Perform satellite survey and imaging of the Area of Interest (AOI).

2. Process the image material with ingenious nanogels and solutions to amplify and highlight spectral anomalies associated with petroleum accumulations.

3. Enhance processing of the image in a small-size nuclear reactor,

4. Plot preliminary boundaries of hydrocarbon accumulation on the AOI map.
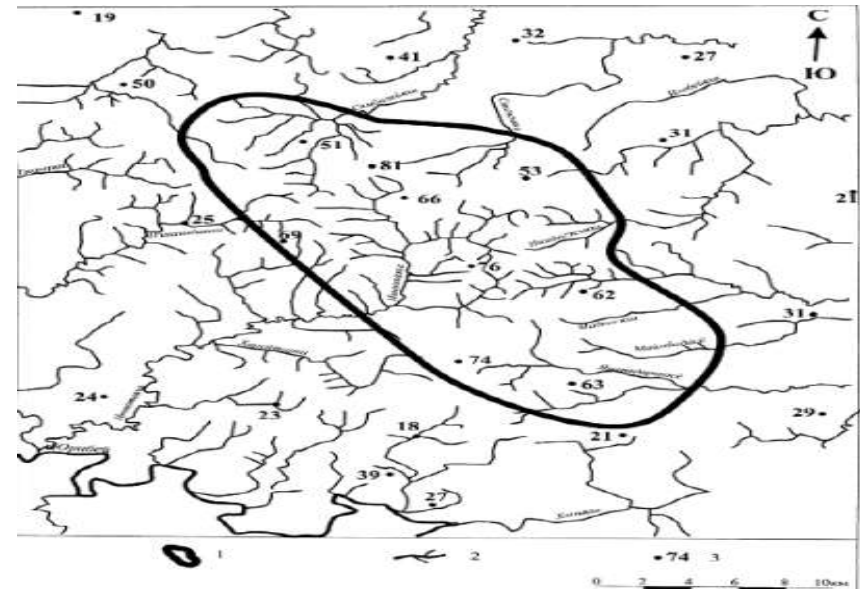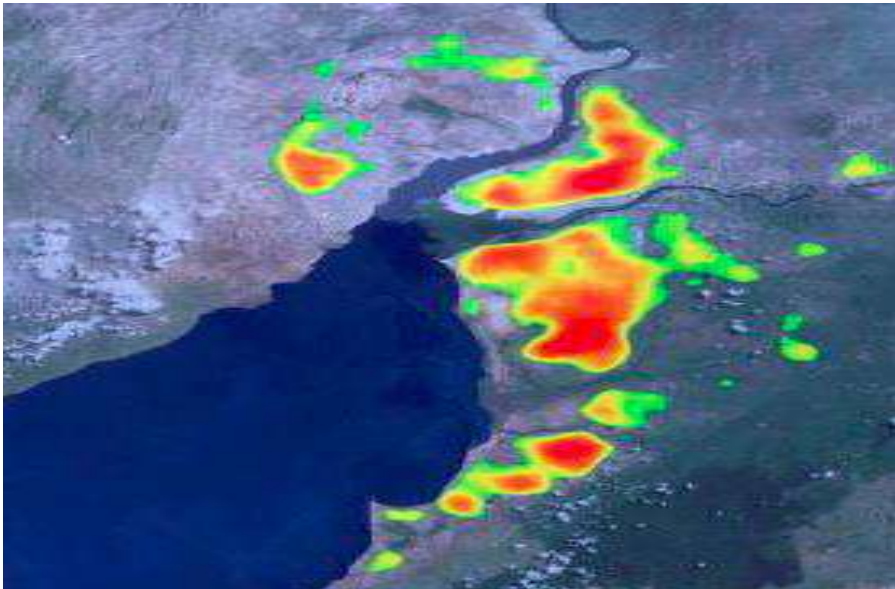
# Step II – RS + Data processing

Interpretation of space **analog** photographs, identification and delineation of areas with anomalies

**1** 

Photo reconnaissance of search areas

**2** 

Processing satellite analogue data images with nanogel solutions

**4** 
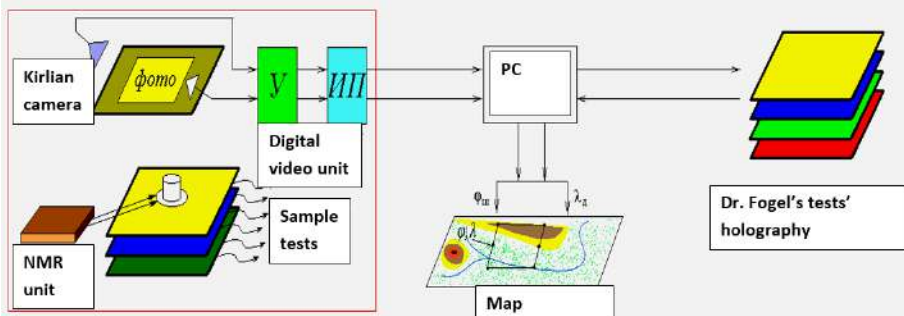
Transferring the boundaries of the light area from the photograph to the map of the search area

**3** 

Exposure of the image in the IR-100 reactor

**5** 

Work results
- The boundaries of the identified anomalous areas;
- Area contours of hydrocarbon, ore bodies and underground waters clusters.

# Step II – RS + Data processing

## What we record and process in Analog Photographs?

- On analog satellite images, characteristic electromagnetic fields (spectra) that exist over each type of "deposits" (oil, water, ore, etc.) are recorded. Characteristic electromagnetic fields (of a specific frequency) are formed over the deposit (anomaly), i.e. on the ground surface due to various chemical, thermal and electrochemical processes in rocks with prolonged migration of oil, gases (other metals in ores) from great depths to the ground surface.

- Poisk technology enables to "visualize" on analog satellite images the characteristic electromagnetic fields in the form of "high brightness zones", after special processing of photo paper using chemical reagents (nanogels), phosphors, sensitizers (layers of mixtures), which are selected for each type of deposits (oil, gas, ore, salt water, fresh water, etc).

- Processing of digital satellite images in the visible spectrum provides only the "primary" visible signs (images) of various anomalies or areas of scattering of mineralization of various metals (copper, gold, molybdenum, etc.).

- Accuracy of identification and delineation of anomalies of various minerals by processing of analog images (Poisk's patented technology) is significantly higher than traditional methods and approaches of geological exploration.

# Step III – Field survey + Theory

1. The resonant frequencies of the reference molecule's atoms are imposed/modulated on the carrier frequency by a high-frequency generator.

2. High-frequency electromagnetic fields, characteristic of the reference sample's elements, are induced above an oil accumulation by its resonating frequencies.

3. Each characteristic electromagnetic field is sequentially recorded by a sensitive receiving device tuned to register resonant frequencies of the reference sample's atoms, ensuring a plausible identification of petroleum accumulations.
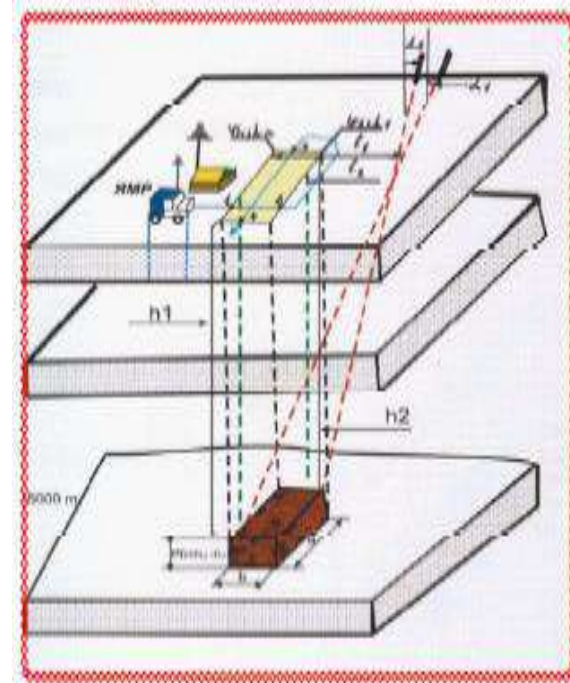


Precise boundaries of petroleum accumulations are plotted on the area-of-interest.

# Step III – Field survey + Theory

**Inspection of the anomalous areas with field equipment, selection of a point for drilling and calculation of reserves**
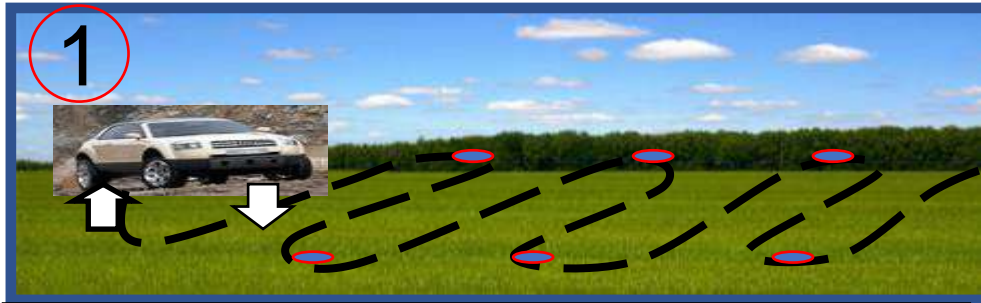


Refinement of areas and boundaries of the site
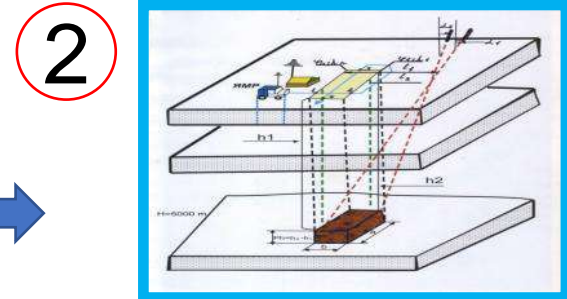


Determining the depths of horizons at measurement points with field equipment
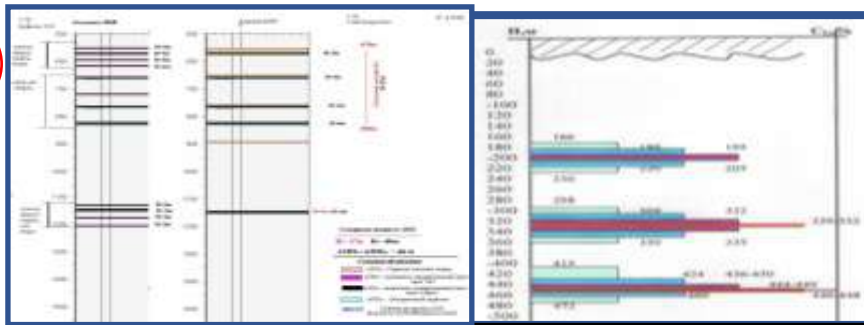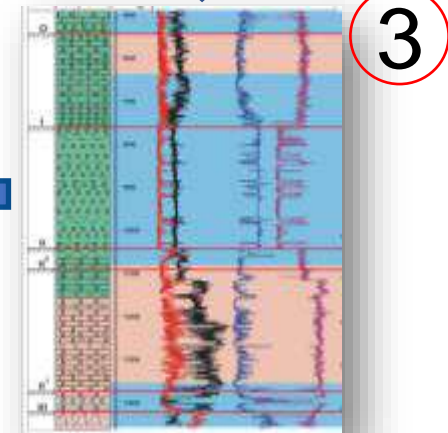


Building depth slices by measurement points



Building deep columns
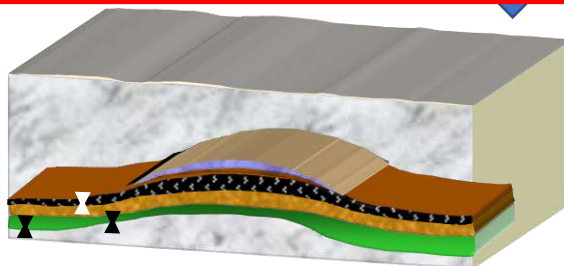


Construction of a volumetric profile of the deposit collector, ore body

# Deliverables

## After Step-1 & 2

Accuracy -  60% to 80%

1. **Maps with identified anomalies associated with petroleum accumulations**
2. **Cross sections with depth of occurrence**
3. **Recommendations where to drill and core**

## After Step-3

Accuracy is about 90%.

1. **Maps with precisely delineated areas of anomalies**
2. **Cross sections with more precise depths of occurrence**
3. **Thickness of potential reservoirs**
4. **Volumes estimation**

**Final Report** might provide the geological substantiation (optional) including:
   a - Geological setting analysis,
   b-  Resources Evaluation

# Deliverables
## Sample 1: step-1



Космический фотоснимок №1. Границы исследуемой площади (Новониколаевка, Крым) S=32 км²

# Deliverables
### Sample 1: step-2
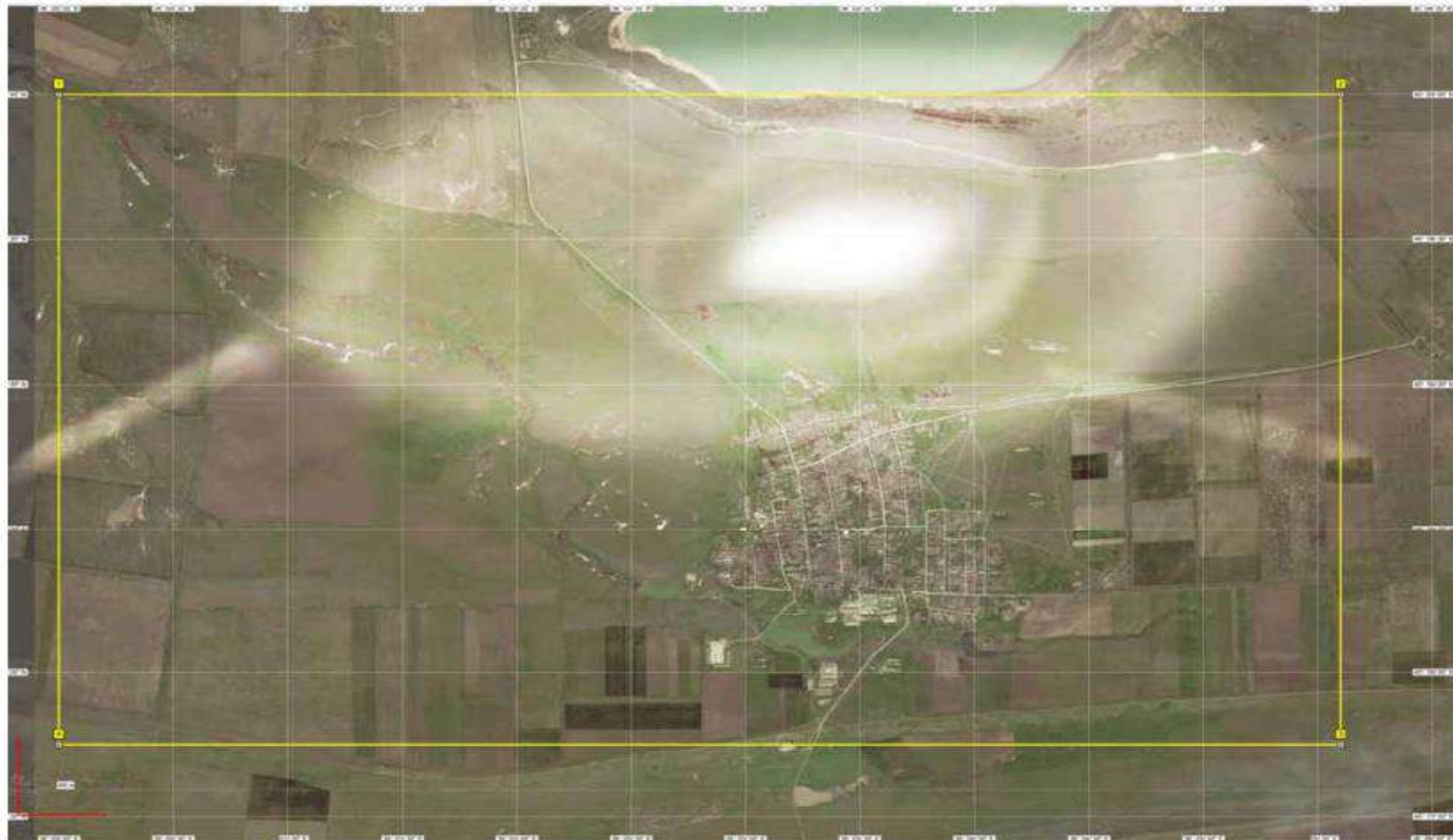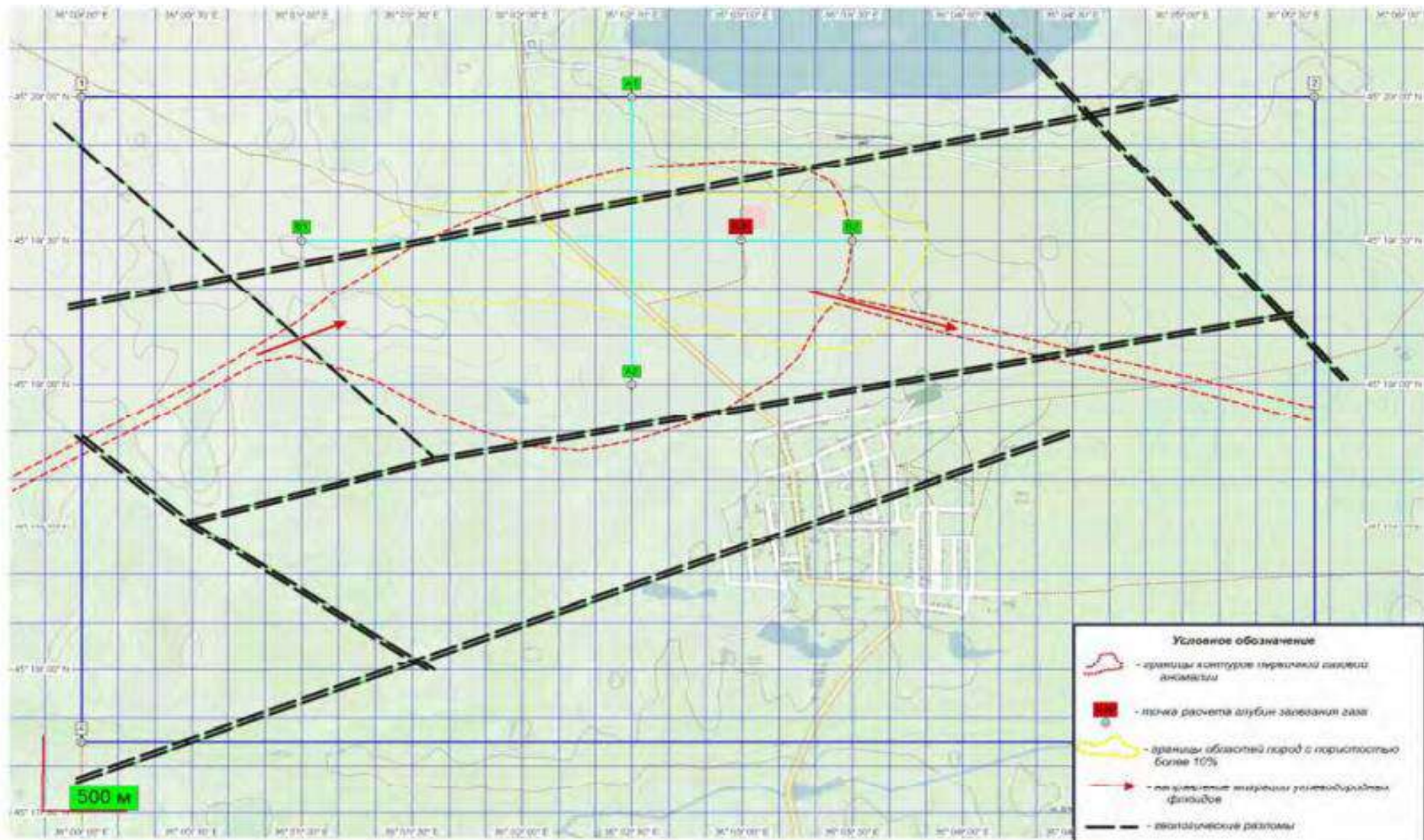
# Deliverables
## Sample 1: step-2
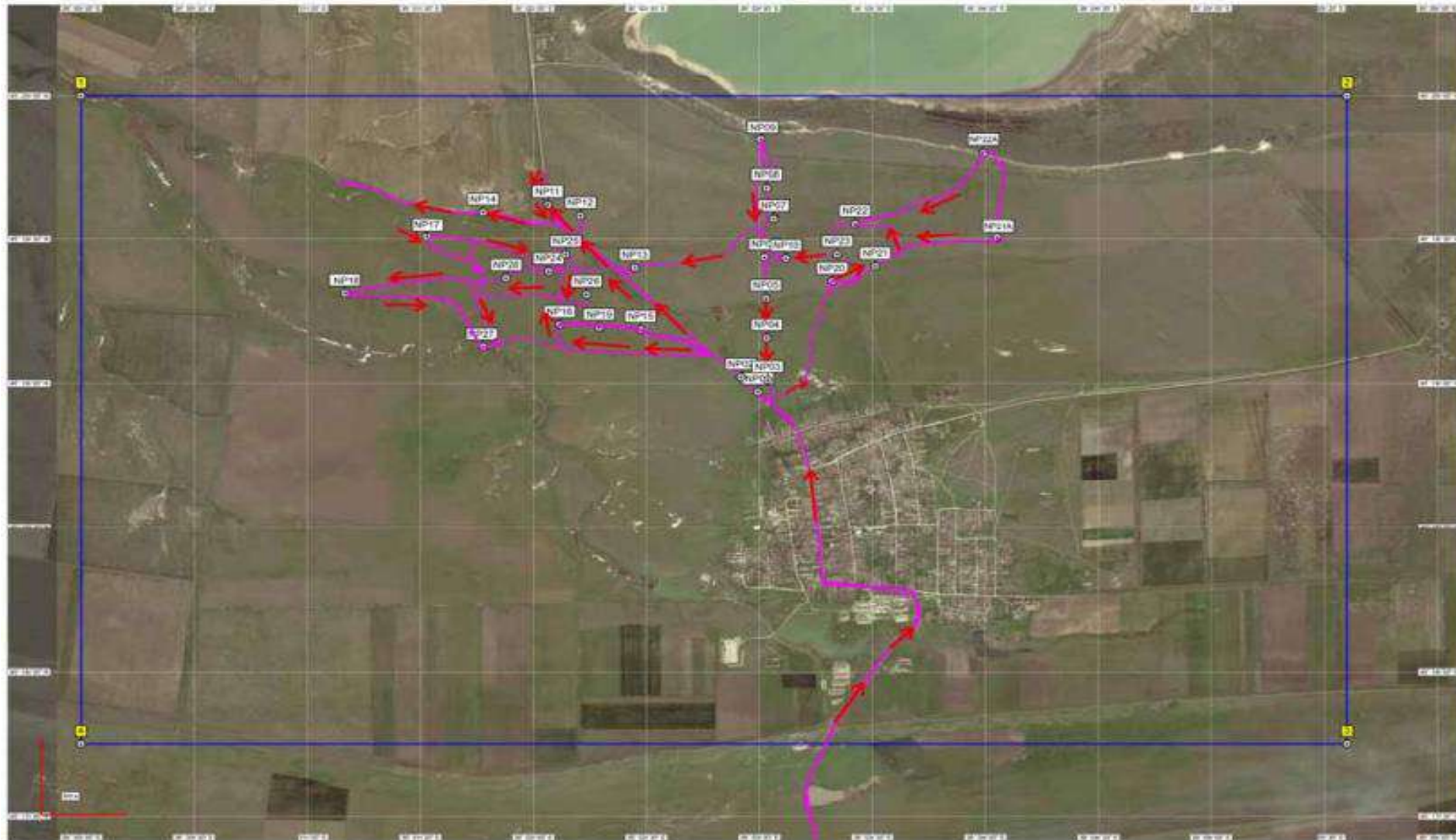
# Deliverables
## Sample 1: step-2

## Sample 1: step-2

# Deliverables
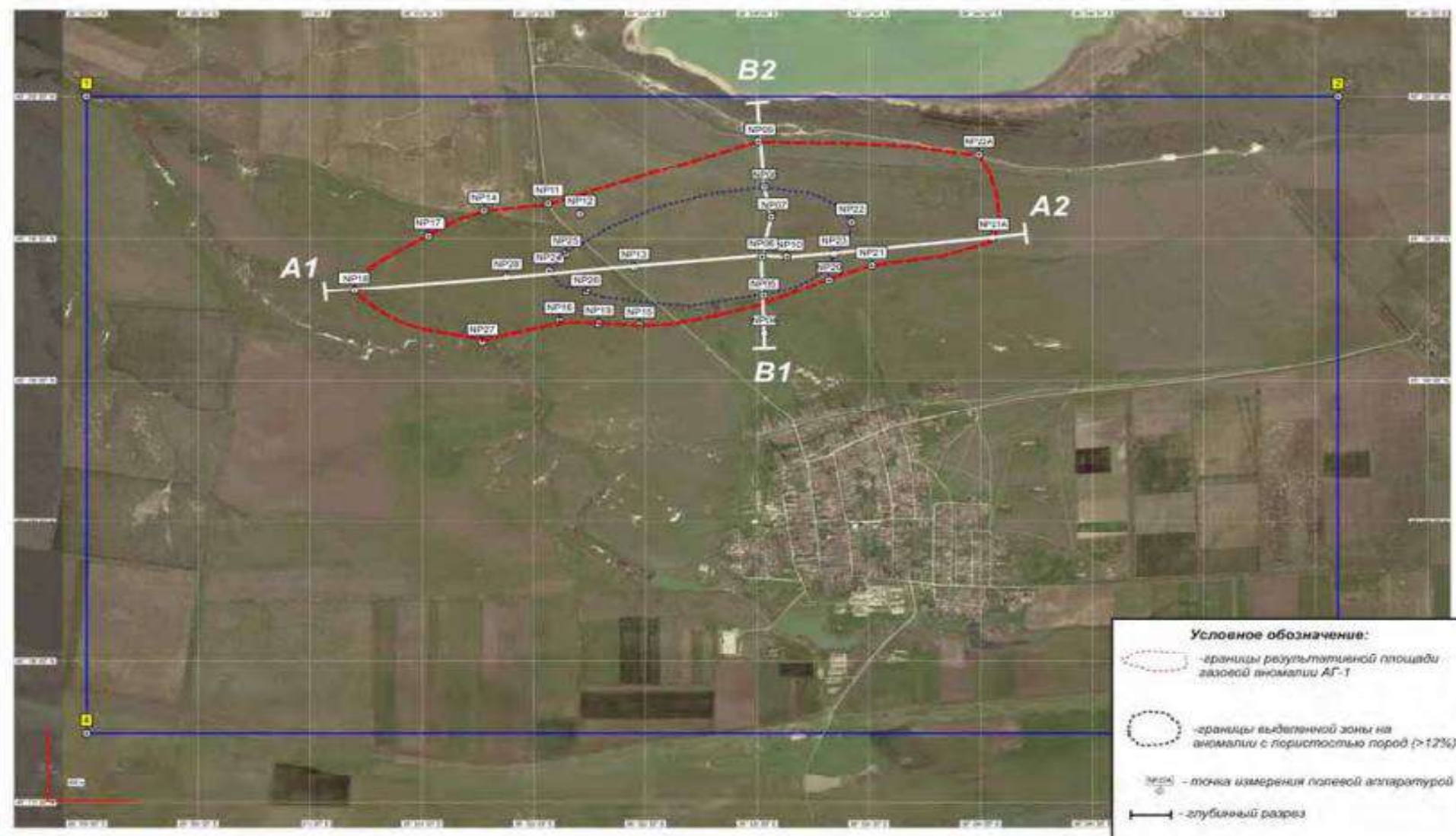
## Sample 1: step-2

# Deliverables
## Sample 1: step-2



Рис. 7. Глубинный разрез газовых коллекторов по направлению А-А2
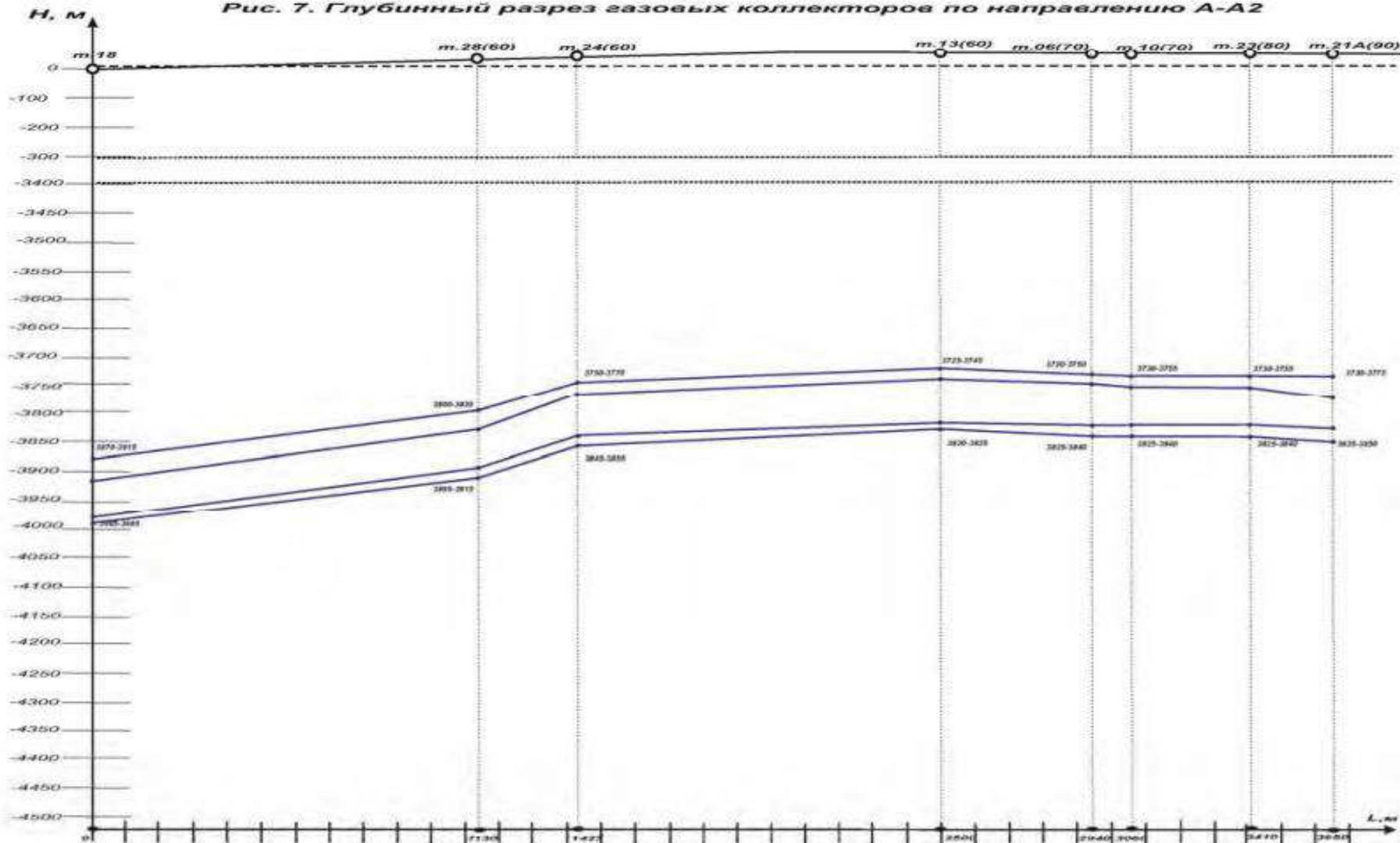
# Deliverables
## Sample 1: step-2



Рис. 8. Глубинный разрез газовых коллекторов по направлению В1-В2
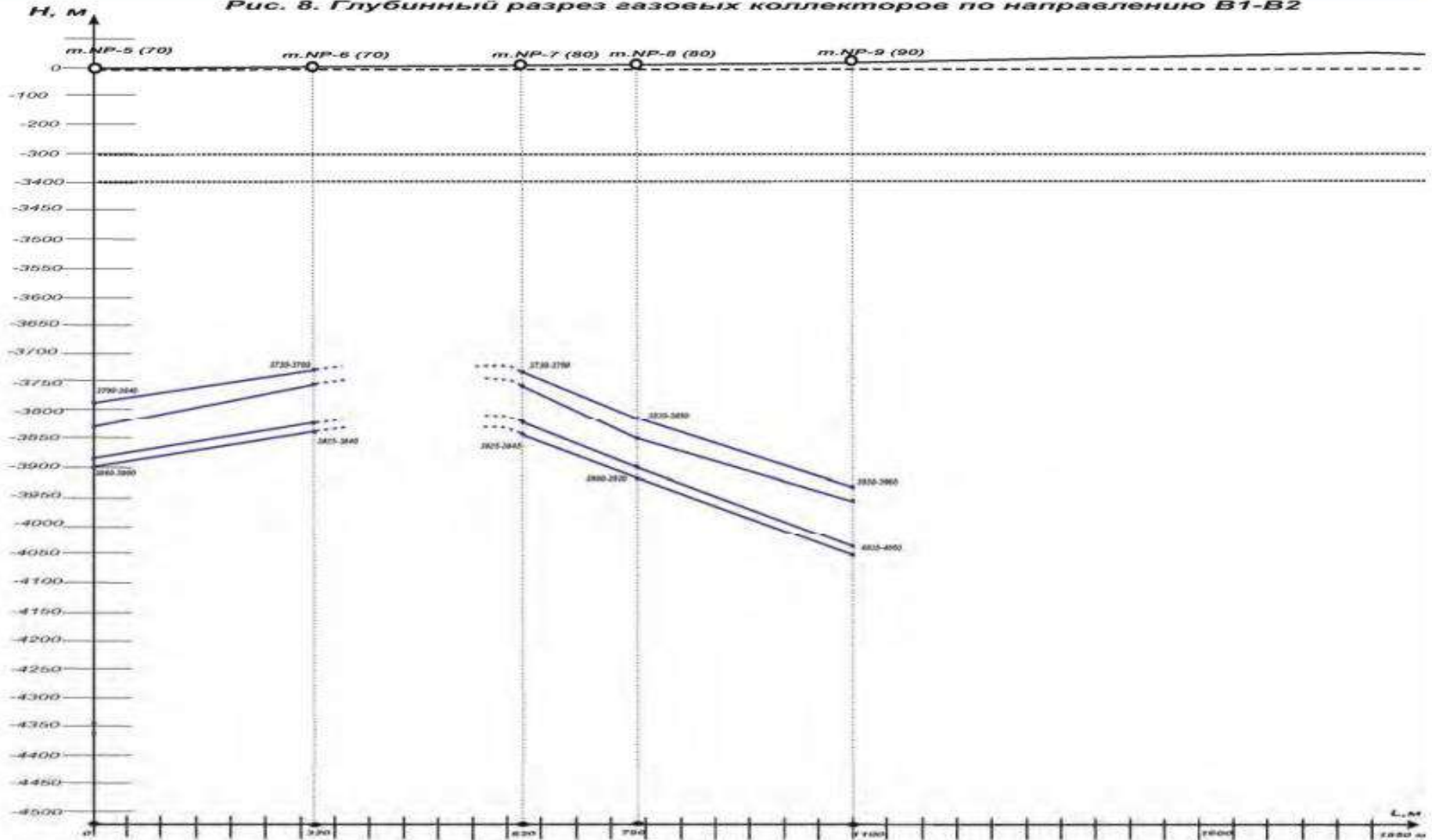
# Deliverables

## Sample 2: step-2

Topographic map with anomalies associated with petroleum accumulations
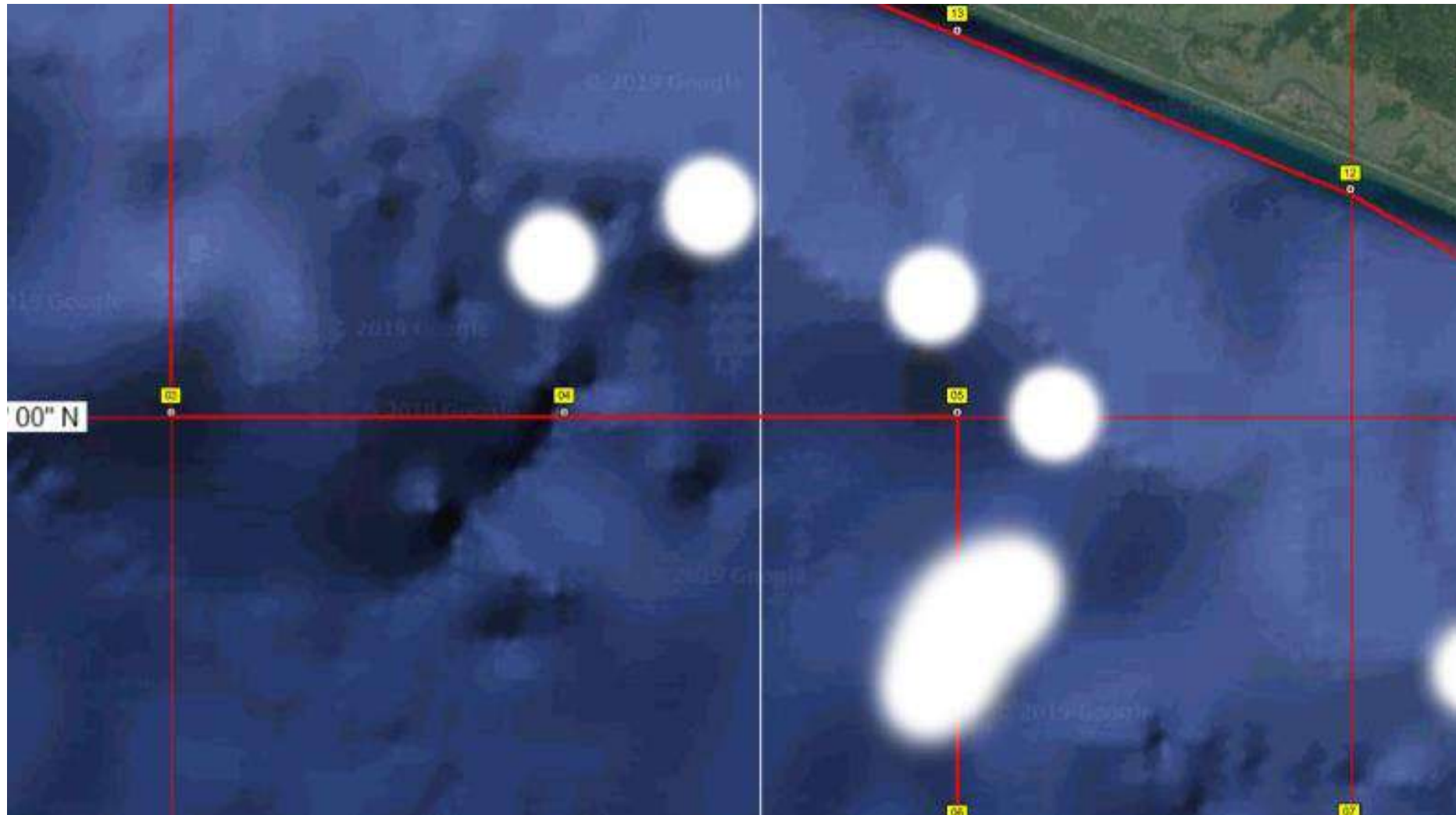
# Deliverables
## Sample 2: step-2
Structure map with anomalies associated with petroleum accumulations
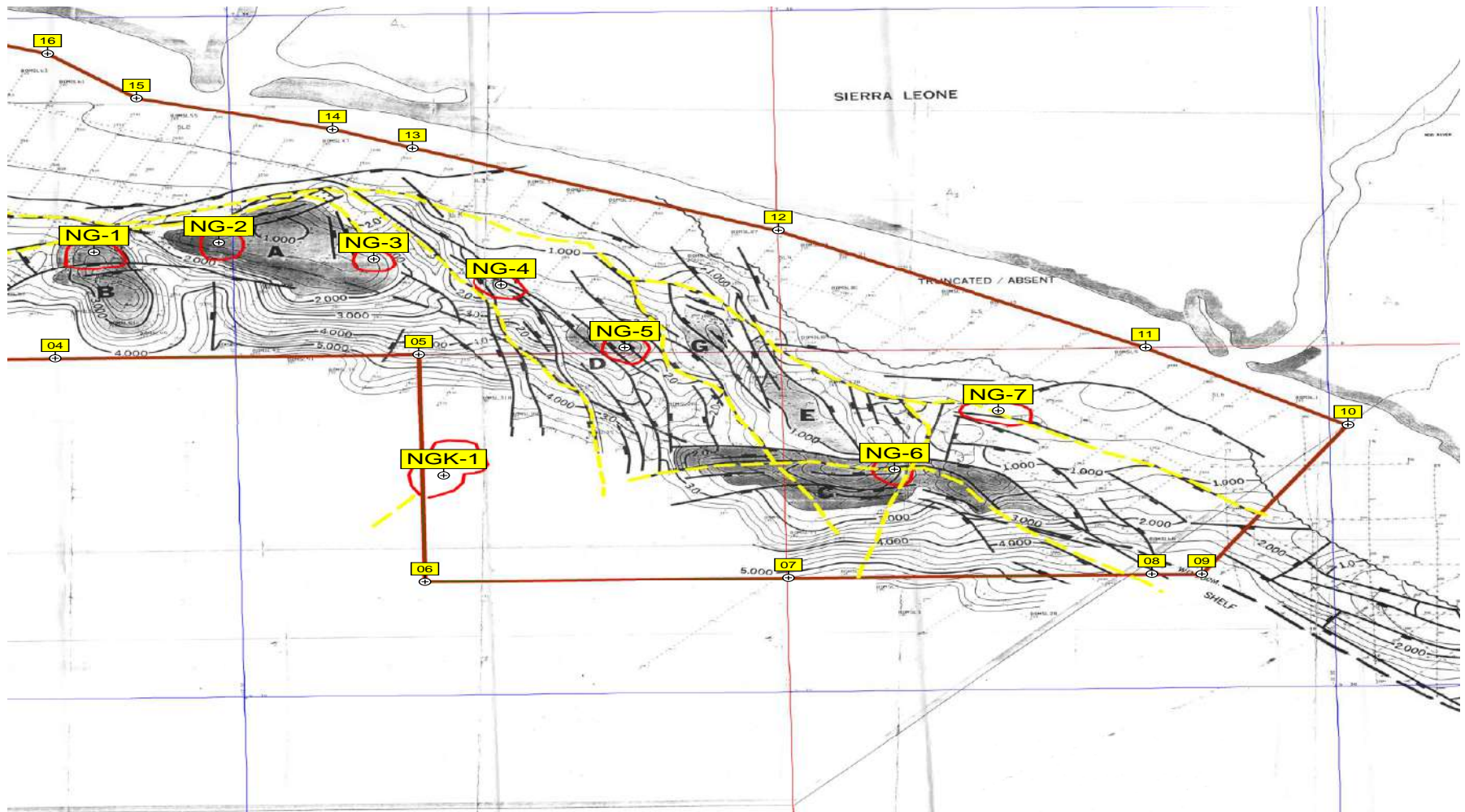
# Deliverables

## Sample 2: step-2

Resources evaluation (optional) provided reservoir properties are known from the nearby oil fields in the same play

**Simulation Settings**    Mode: EXPLORATION PROSPECT    Notes

|  | Original In Place | | Prospective Undiscovered Recoverable Reserves | | | | Total Geologic Pre-Drill | Above Commercial Threshold (Option is OFF) | Above Economic Threshold (Option is OFF) |
|  |  | | Liquids | | Sales Gas | | | | |
|  | Oil | Gas | Oil | Total Cond | Non-Assoc | Soln | | | |
|  | MMMT | MMCM | MMMT | MMMT | MMCM | MMCM | MMMTE | MMMTE | MMMTE |
| P99 | 12,45 | 0,00 | 2,06 | 0,00 | 0,00 | 0,00 | 2,06 | NA | NA |
| P90 | 24,76 | 0,00 | 4,20 | 0,00 | 0,00 | 0,00 | 4,20 | NA | NA |
| Mode | 39,15 | 0,00 | 7,21 | 0,00 | 0,00 | 0,00 | 7,21 | NA | NA |
| P50 | 57,77 | 0,00 | 10,33 | 0,00 | 0,00 | 0,00 | 10,33 | NA | NA |
| Mean (P99->P1) | 72,15 | 0,00 | 13,00 | 0,00 | 0,00 | 0,00 | 13,00 | NA | NA |
| P10 | 142,53 | 0,00 | 26,25 | 0,00 | 0,00 | 0,00 | 26,25 | NA | NA |
| P1 | 291,68 | 0,00 | 54,45 | 0,00 | 0,00 | 0,00 | 54,45 | NA | NA |

Current settings…
Estimating method:
VOLUMETRIC (Area X Net Pay X HC Yield)
Intermediate Simulation: 5000 Iterations
Resources Simulation: 5000 Iterations
Truncations:
    Input= 0,00/1,00
    Output= 0,00/1,00
Complex Trap option OFF
Area-Pay correlation= 0
Raw Gas Surface Loss: NONE
Percentile Sorting: HC Equiv only

| Chance of Success >> | Pg- Chance of Geologic Success (>=Ab Min reserve) | Pc- Chance of Commercial Success (>=MCFS) (Option is OFF) | Pe- Chance of Economic Success (>=MEFS) (Option is OFF) |
|---|---|---|---|
|  | 11,3% | NA | NA |

In this product, the term 'reserves' denotes PROSPECTIVE RESOURCES, or the ultimate recoverable resources that will be produced should this prospect become a field. It does not conform to the definition of 'proven reserves' provided by the U.S. Security and Exchange Commission.

# Key Features and Benefits

1. *Highly Cost-effective and Time-effective technology for identifying the focus area of hydrocarbons and other minerals.*
2. *This technology is unique with analogue image data processing.*
3. *The reliability of the obtained results based on NMR & remote sensing data after Stage-1 (Step-1&2) is 60%-80%, and after performing field work in Step-3 is about 90%.*
4. *3D Seismic data acquisition area could be finalized without investing time and money in 2D seismic and other geophysical surveys.*
5. *If seismic is already done in any area, this NMR-RS technology helps in identifying and validating the drilling locations. Also helps in the assessment of probable reserves of hydrocarbons, ores and groundwater prior to drilling.*
6. *This Technology is very useful in the remote and topographically challenging terrains like Manipur, Mizoram, Nagaland, J&K states of India.*
7. *Detection of hydrocarbon and geothermal waters up to depth of 5000 m, ore bodies up to 1500m, underground drinking water to depths of 1000 m.*
8. *Vertical resolution of the anomaly after Step-2 is 100m and after Step-3 is 30-50m.*
9. *The total time for the execution of NMR-RS exploration work on survey area of 1000 sq. km. is approximately 2 months for Step-1 & 2, and 5-6 months for Step-1,2 &3.*

# Projects

- Oil, Gas and Gas condensate
- Coal
- Uranium
- Zinc, Lead
- Molybdenum
- Copper
- Polymetallic ore
- Diamond etc.

**About 300 projects worldwide (Russia, Mongolia, Colombia, Ukraine, USA, Indonesia, Australia, Congo etc.)**

# Case Study I



License block in Indonesia

Productive wells are sitting within the areas outlined marked with red color
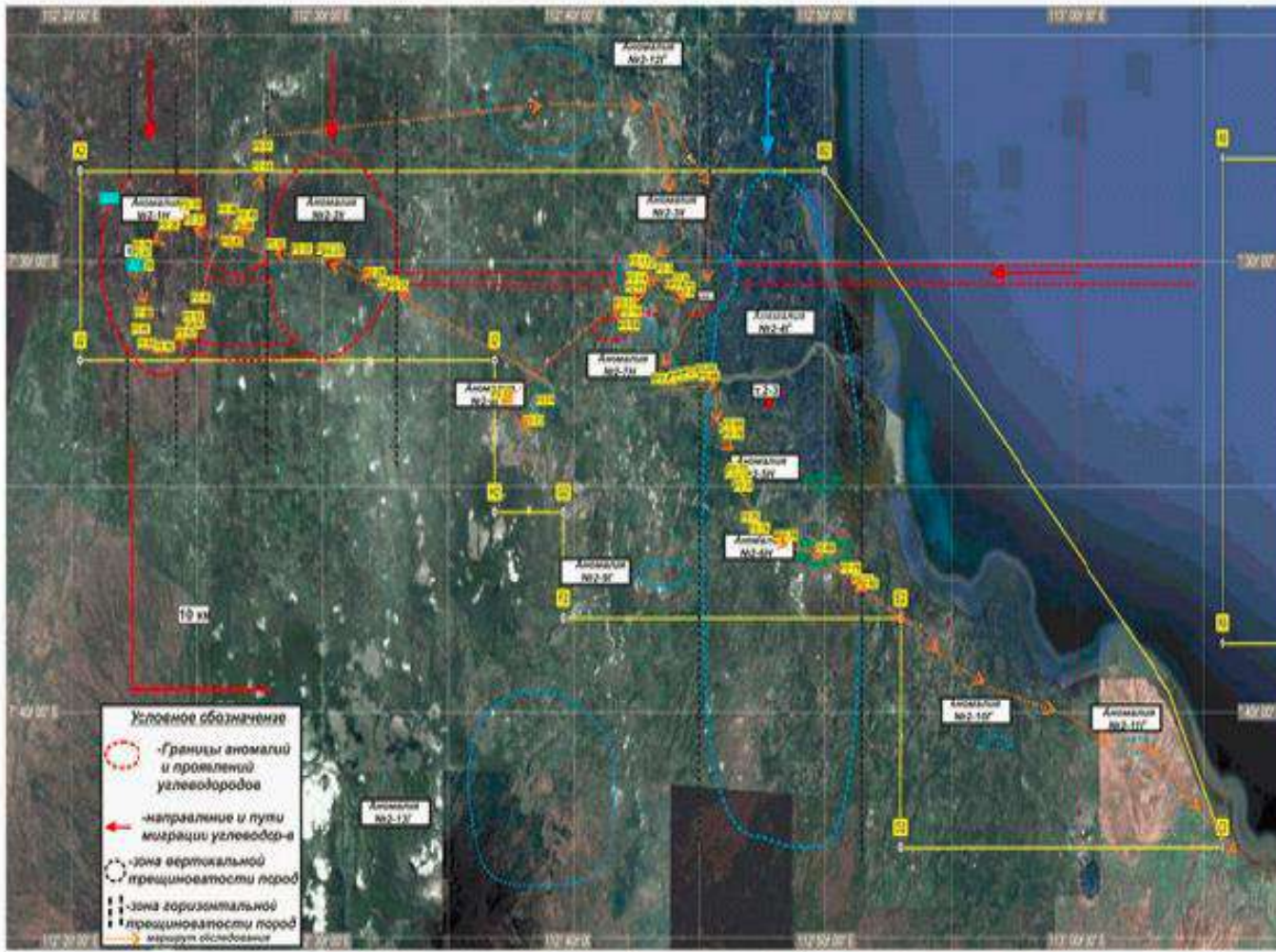
# Testimonial

**Russ Techno**
Tel: +62 8170 228877   FAX: +62 21 84306196

**CV RussTechno Indonesia**

Ruko Permata Boulevard Blok BA, No.1
Jl Pos Pengumben Raya Jakarta Barat 11550 – INDONESIA

Date : 1 June, 2012 r.

Re: SBRDSS report reference

In accordance Contract No.1, 28.11.2011 between RussTechno Indonesia and Sevastopol State University, Sevastopol's specialists (head of team - Ph.D. Kovalev N.I.) were involved with a set of equipment "Poisk" for remote search for oil and gas with identification its depth and deposit on Brantas Block in Java, Indonesia total area 3050 km2. Off-shore – 2 blocks and On-shore – 3 blocks.

Previously, these areas were studied by traditional seismic methods and have more then 30 wells.

The study was performed in February 2012. Based on the results of study on Brantas Block by using remote method SBRDSS Sevastopol specialists discovered total 31 hydrocarbon anomalies.

SBDRSS remote method was proven by compare with seismic date available in Lapindo Brantas company. This method is cost effective and very accurate in depth and deposit result.

Regards,

Thanigasalam
President Director

# Case Study II
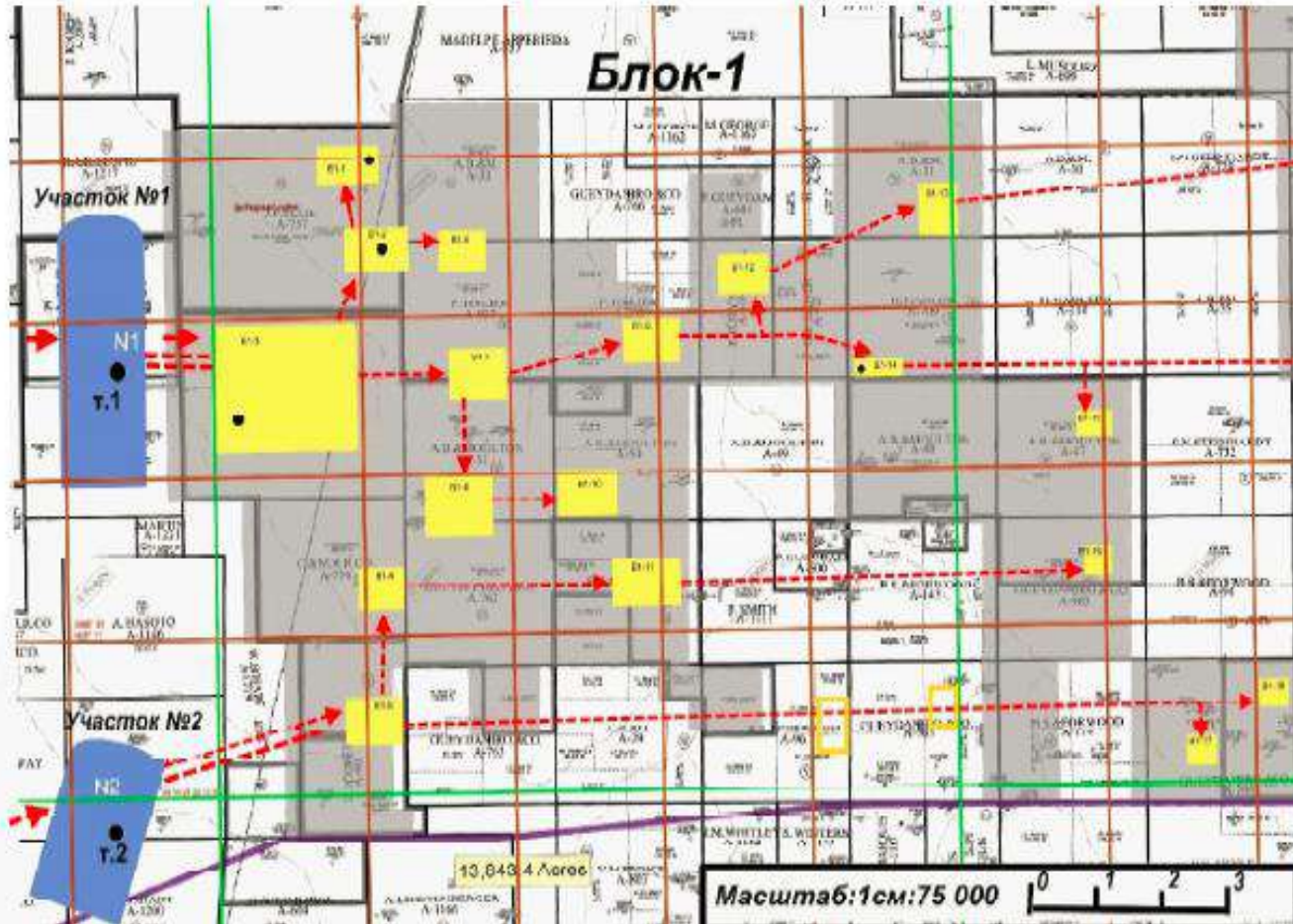


License block in Texas, USA

Well N-1 penetrated shale oil formation as indicated by the corresponding anomaly

# Testimonial

# Case Study III



## License block in Utah, USA

The oil accumulations and wells locations have proved the delineated anomalies. Recommendations were made to drill new wells at the identified anomalies to the north-east.
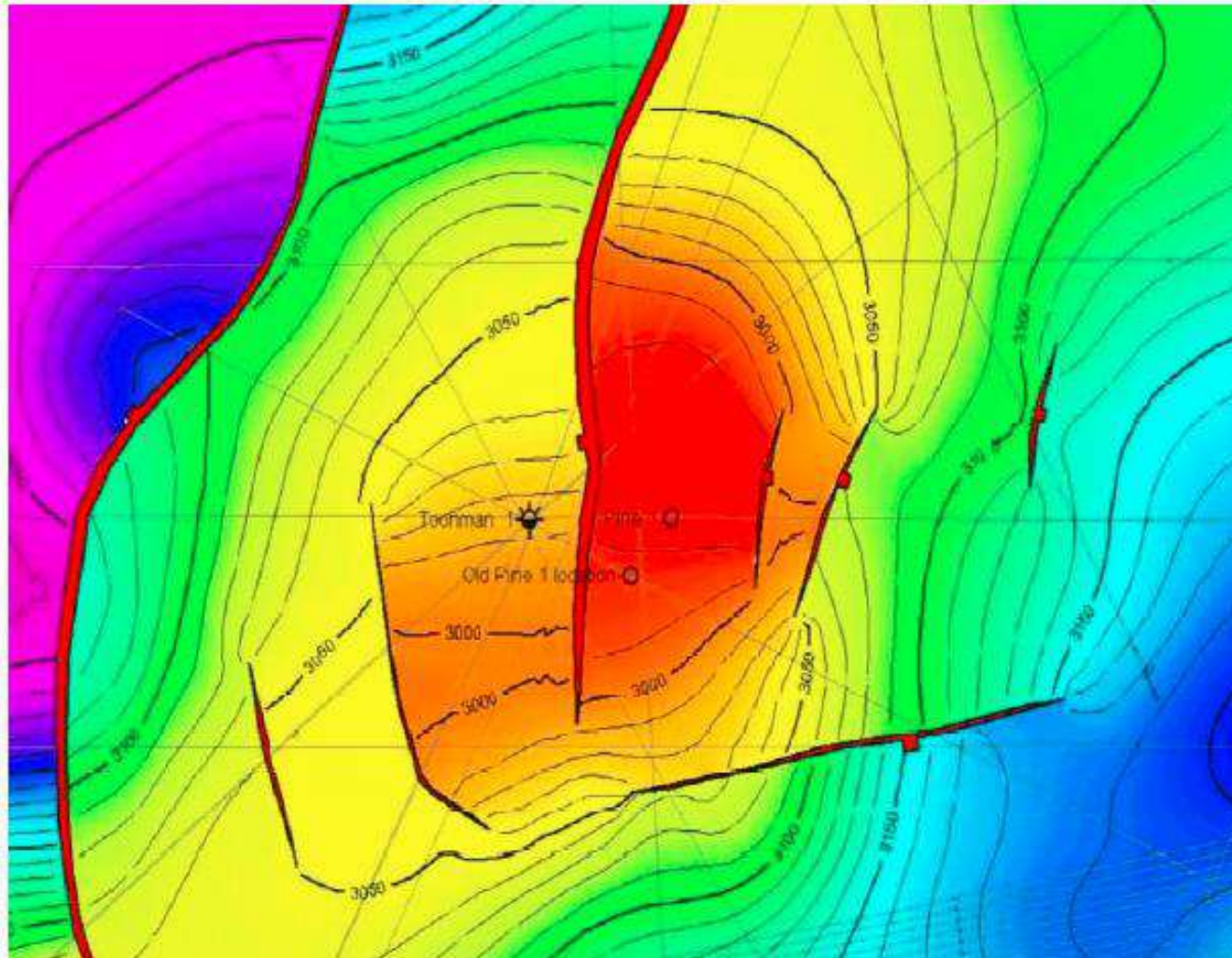
# Testimonial

# Case Study IV



## License block Pel-105 in Australia

Well Pine-1 location was changed as suggested the identified anomaly. The well has been drilled and proved to be productive.

# THANKS FOR YOUR TIME

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# Points of Consideration

1. *Highly Cost-effective and Time-effective technology for identifying the focus area of hydrocarbons and other minerals.*
2. *This technology is unique. No analogue image processing available in the world.*
3. *The reliability of the obtained results based on NMR & remote sensing data after Step-1 & 2 is 60%-80%, and after performing field work in Step-3 is about 90%.*
4. *3D Seismic data acquisition area could be finalized without investing time and money in 2D seismic and other geophysical surveys.*
5. *If seismic is already done in any area, this NMR-RS technology helps in identifying and validating the drilling locations. Also helps in the assessment of probable reserves of hydrocarbons, ores and groundwater prior to drilling.*
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