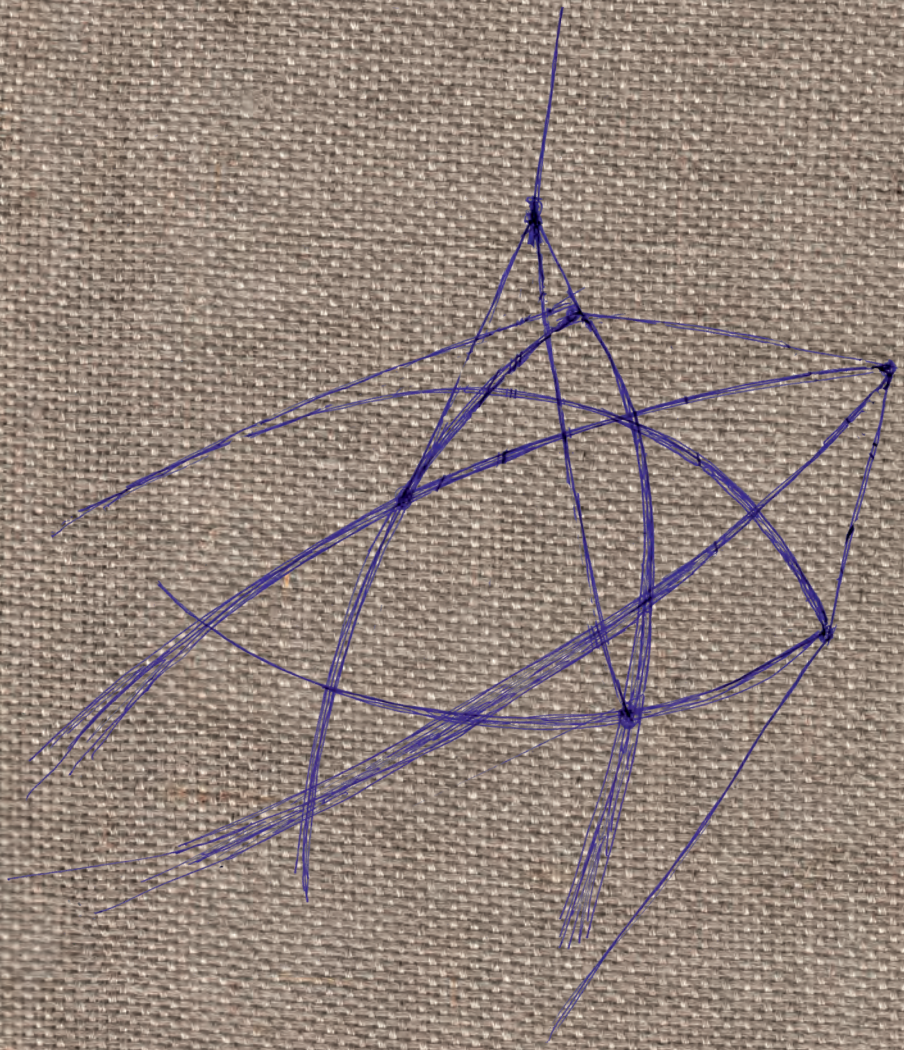
GEOTECHNOLOGIES
2015



WE

Today **WE** are the GeoTechnologies group of companies
- GeoTechnologies, Russia
- GeoTechnologies, North America

We operate worldwide and our main business lines are:

- developing of airborne geophysical instruments
- delivering of airborne geophysical turn-key technologies, personnel training and technical support
- providing of airborne geophysical surveys

Our technologies are complete and balanced. We achieve not only high precision and sensitivity of our instruments, but also high reliability and productivity of airborne geophysical systems even in the most difficult geographical and climate conditions.

Professionalism of our employees, long term experience in technologies development, wide range of own geophysical equipment and software, capability to generate and apply scientific knowledge are our recipe for success.

We'll be happy to answer all the questions, just contact us.

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USA
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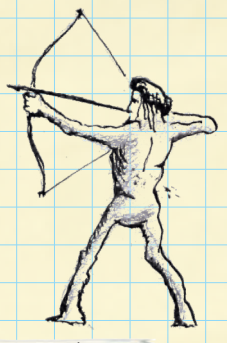
PDAC, Trade Show:
booth # 444

We've got many scientific and business partners - Institute of Control Sciences of RAS, VSEGEI, Alrosa, Geoken and many others.

JOIN US!

OUR TECHNOLOGIES



are

FAST AND PRECISE:

ensure perfect data quality combining excellent precision with high speed and resolution.

RELIABLE AND EASY-TO-USE:

even the survey of small areas is economically viable - all instruments are easy to transport and mount, compact and effective

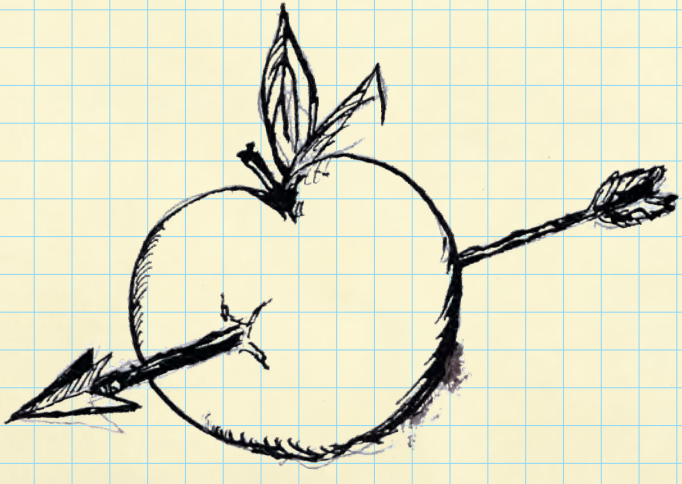
SAFE:

our systems are easy to fly with, they provide comfortable working conditions for a pilot and deliver accident-free operations.

CUSTOMER-FRIENDLY:

high automation of airborne geophysical equipment and processing software provides fast delivery (within few days after) of survey data ideal for geological and geophysical interpretation.

ALWAYS HIT THE TARGET



THANKS TO

our scientific research, ongoing development of geophysical instruments, methods of signal processing and software. Continuous evolution of our capabilities ensures high data quality, effectiveness of geological and geophysical interpretation, accuracy of mapping and efficient exploration.

OUR CAPABILITIES

All these systems are developed and produced by our specialists

AIRBORNE ELECTROMAGNETIC SYSTEMS

Developed in 2005 EM4H is a four-frequency AEM system. There are two EM-4H modifications: fixed-wing (AN-2 and AN-3) and helicopter-borne (MI-8). High position of transmitting dipole and large footprint make EM-4H the system of choice for regional mapping.

Developed in 2010 EQUATOR is a fully towed helicopter-borne time-domain electromagnetic system. Full-time signal measurement allows transformation of collected data to frequency-domain representation. The system is light and compact, it combines perfect aerodynamics along with high sensitivity and provides excellent data quality and high penetration depth.

AIRBORNE MAGNETIC & DATA ACQUISITION SYSTEMS

We developed high-precision aeromagnetic system GT-MAG and magnetic variation station GT-MVS.

GT-MAG has an integrated system for monitoring of measurement conditions that allows connection of additional sensors (thermometer, barometer and so on).

GT-MVS base station works autonomously and use wireless data transfer.

INFRARED SCANNER

Autonomous line scanner of long-wave infrared range (8-14 μm) was developed for airborne topographic thermal surveying. Combining high energy (0.05 K) and angular (0.7 mrad) resolution ensures perfect quality of infrared images.

NAVDAT

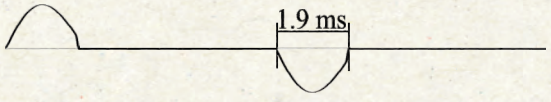
NavDat provides data control and high accuracy navigation for airborne geophysical surveys employing any geophysical equipment.

AIRBORNE ELECTROMAGNETICS

EQUATOR

Helicopter-borne
Time-Domain Electromagnetic
and
High-Precision Magnetic
System

SPECIFICATION

Electromagnetic measurements	
Principle of operation	Time-Domain & Frequency-Domain
Base frequency	77 Hz
Dipole moment (NIA)	100 000 Am^2
Pulse shape	
Output data in time domain	14 off-time channels from 5 μs to 4.5 ms, X,Y,Z components
Output data in frequency domain	15 frequencies from 77 Hz to 15 kHz, X,Y,Z components
Total weight	300 kg
Transmitter loop diameter	11.5 m
Tow cable length	70 m
Receiver placement	In the towed bird, 40 m from transmitter loop
Power requirements	100 A from 27 V network
Survey speed	0-200 km/hr

Magnetic measurements	
Sensor	SCINTREX CS-3
Sensitivity	0.6 pT/√Hz
Sample rate	1000 Hz
Output rate of 'distilled' data	25 Hz
Synchronization	by GPS
Sensor placement	In the towed bird

EM-4H

Frequency-Domain
Airborne Electromagnetic System

SPECIFICATION

Electromagnetic measurements	
Principle of operation	Frequency-Domain
Frequencies	130, 520, 2080, 8320 Hz
Dipole moments	20000, 10000, 6000, 3000 Am^2
Waveform	Sum of four harmonic signals
Output data	Inphase and quadrature X, Y, Z components for four frequencies
Total weight	200 kg
Transmitter loop area	42 m^2 for An-2, An-3 fixed-wing aircrafts, 60 m^2 for Mi-8 helicopter
Tow cable length	70 m
Receiver placement	In the towed bird, 70 m from transmitter loop
Power requirements	30 A from 27 V

Magnetic measurements	
Sensor	SCINTREX CS-3
Sensitivity	0.6 pT/$\sqrt{}$Hz
Sample rate	100 Hz
Output data rate	100 Hz
Synchronization	by GPS
Sensor placement	In the towed bird

MAGNETOMETERS

FOR AIRBORNE SURVEY

Airborne magnetometer and data acquisition system GT-MAG-2 for high-precision survey with one or two sensors suits both stinger-mounted and towed (in a bird) configurations.

For stinger-mounted configuration magnetic compensation software ReinMag is used for data processing.

GT-MAG-2 magnetometer and computer of NavDat system

'WALKING' and BASE STATION

We produce two GT-MVS modifications:

- walking magnetometer
- base station

Sensor: cesium or potassium vapour.

For all operations including system control, data overview and download a smartphone is employed.

ARE YOU LOOKING FOR AN AIRBORNE OR GROUND MAGNETOMETER?

Always a broad selection,
enough for everyone
Come in, you will not regret!

This table will help you to make your choice.

	GT-MVS-SB (Base Station)	GT-MVS (Walk)	GT-MAG-2 (Airborne)
Precise sensor type	High-sensitivity Self-oscillating split-beam (Cs, K, ...)		
Sensor number	1	1	2
Sensitivity	0.0002 nT/√Hz		
Resolution	0.001 nT		
Sample rate	1 Hz	up to 1 000 Hz	up to 1 000 Hz
Fluxgate chanels	-	-	3
Fluxgate sample rate	-	-	same as for precise channel
Data storage	USB-flash	USB-flash	-
Data output interface	Wi-Fi, USB	Wi-Fi, USB	USB
Internal GPS	GlobalSat OEM GPS Receiver ET-332, 1 Hz	GlobalSat OEM GPS Receiver ET-332, 1 Hz	up to two GPS-receivers (1 - 100 Hz)
External GPS	Any with serial output	Any with serial output	-
Radar altimeter	-	-	TRA 3000/3500
Standard software	NavDat (ground module)	NavDat (ground module)	NavDat, Reinmag
Power supply	10-26 V / 15W (45W max)	10-26 V / 15W (45W max)	22-31V / 15W (60W max)
Console dimensions	170x215x35 mm	170x215x35 mm	325x290x70 mm

AIRBORNE INFRARED IMAGING

Successfully used for engineering and hydrogeological studies, for diagnostics of various industrial structures, underground heat supply network, oil and gas pipelines.

INFRARED SCANNER SCAN-T

Linear scanning technique allows to obtain thermal image with maximum energy resolution and to georeference it with topographical accuracy. Wide view angle combined with high geometrical resolution provide high efficiency of survey.

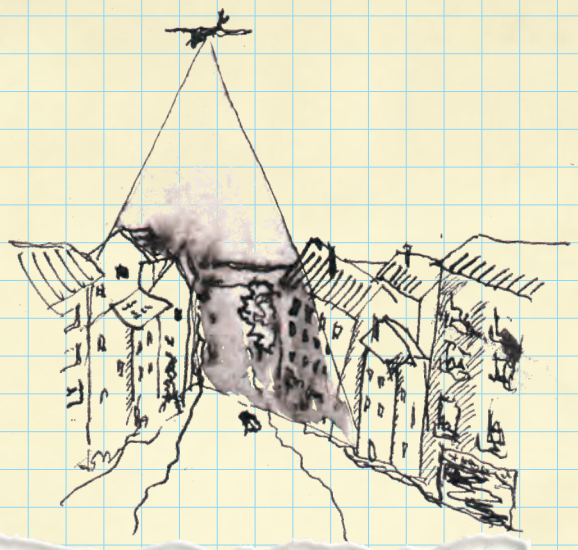
SPECIFICATION

Operating principle	scanner: image is captured line by line
Angle of view	120º
Scanning frequency	230 lines per second
Ray width	2.4'
Number of points in a line	3500
Wavelength range	8-14 μm (LWIR)
Sensitivity	0.03ºC for background temperature 20ºC
Software	NavDat
Navigation system	integrated navigation system based on - GPS/GLONASS(Javad/Topcon/Novatel); - strapped-down attitude system; - radar altimeter TRA 3000/3500.
Accuracy of navigation system	- attitude angles — 1º - position — 3-5 m
Sensitivity of attitude system	less than 1'
Noise of positioning	less than 10 cm
Dimensions	50x30x30 cm
Weight	30 kg
Installation	outside fuselage (Mi-2, BK-117, Cessna-172) or inside fuselage in a hatch (Mi-8, Ka-26, An-2)
Output image	Raster layer in ArcGis format

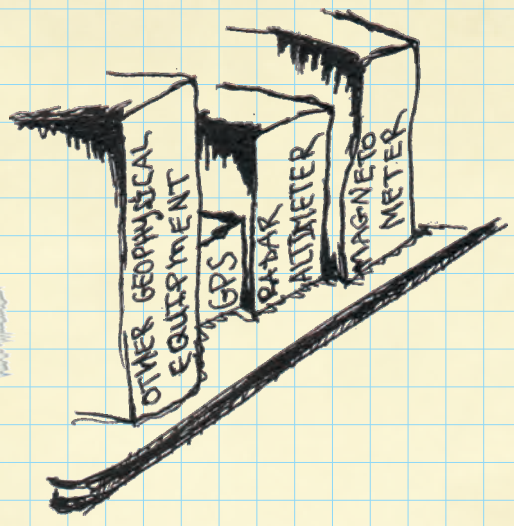
FEATURES

Geometrical accuracy of infrared image and its georeferencing are provided by an integrated navigation system.

Here you can see the result of an image correction:
on the left: the image before correction
on the right: automatically corrected image



DATA CONTROL AND NAVIGATION

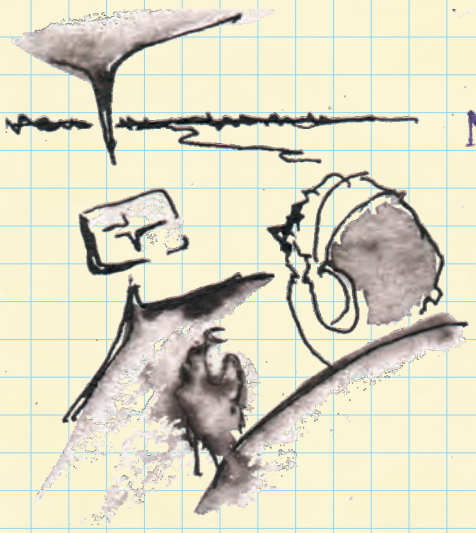


NAVDAT SYSTEM

Allows for integration of all geophysical instruments almost as simple as putting all necessary books on a shelf.

NAVDAT controls collected data

It receives and records data from all elements of geophysical system, verifies their quality and integrity. Protection from operator's mistakes is guaranteed!



NAVDAT ensures high-accuracy navigation

Following navigation instructions from the indicators of NavDat system a pilot can fly along routes with 2-meter accuracy and turn from one route to another within 1-2 minutes.

NAVDAT monitors survey process

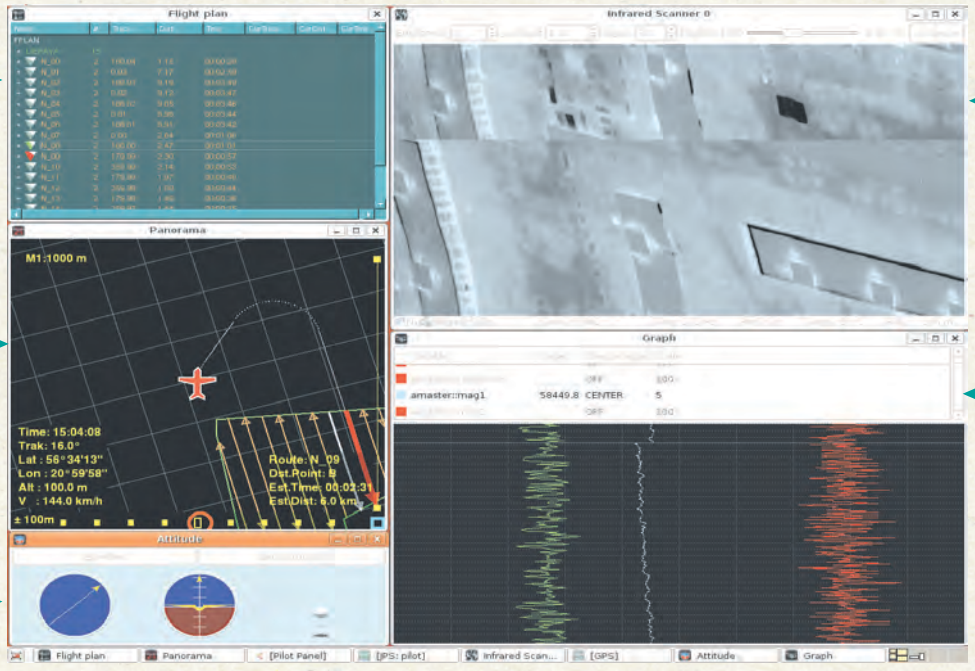
All measured signals and navigation parameters are visualized on the screen of the on-board computer.

For survey without operator in case of equipment failure a pilot obtains warning signal immediately.

The example of NavDat screen for an airborne infrared survey

Navigation map and fight plan file

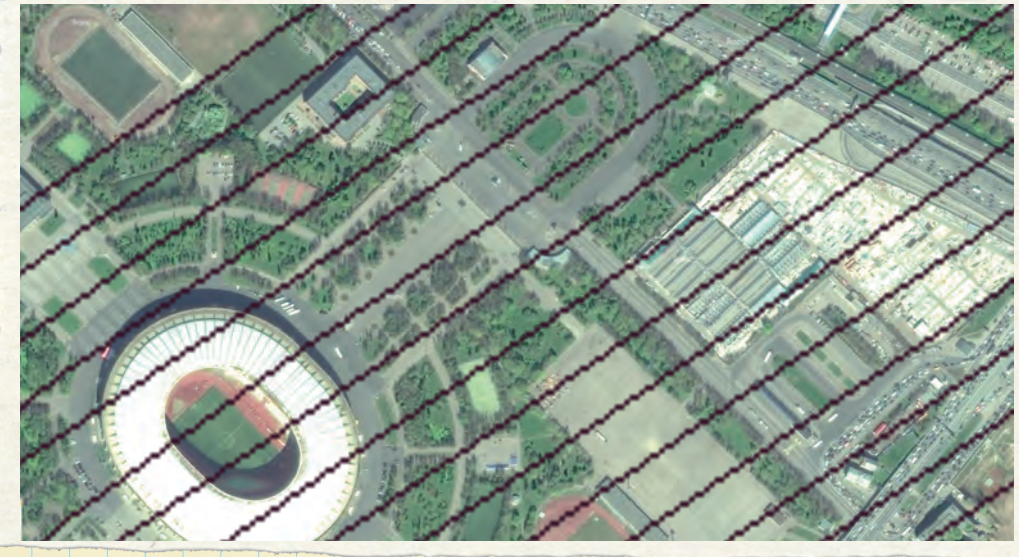
Infrared image in real time



Parameters of gyro system

List of measured signals and their charts

The fragment of flight paths. The route distance is 50 meters.



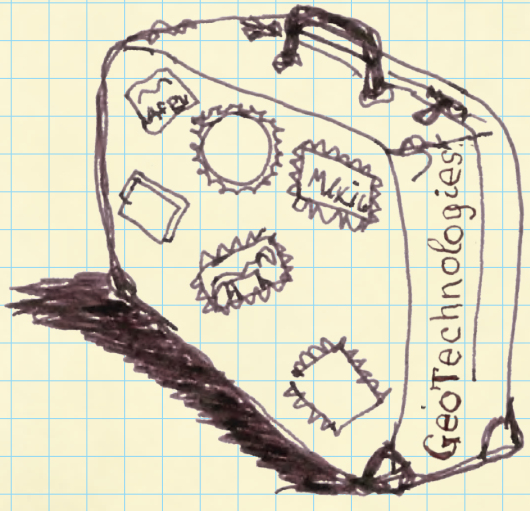
AROUND THE WORLD

Our technologies are operated worldwide

Here is only part of our geography.

By now our instruments are used by many geophysical companies in Russia and abroad. We look after our customers and listen attentively to their suggestions and comments. Working with our support customers can always rely on the experience of our professionals.

Performing a survey our geophysicists always achieve the best possible results. Constant support of the developing group – of engineers and programmers – allow them to use highly effective geophysical data processing methods and interpretation software.



SCAN-T, Mexico, 2011

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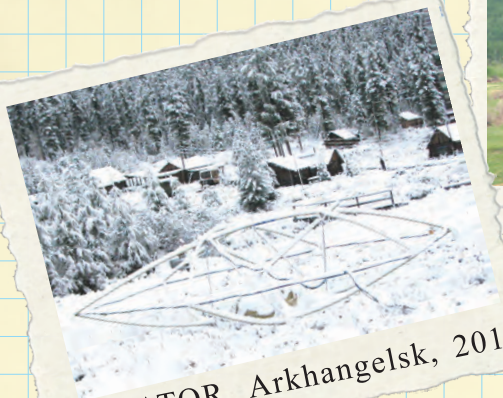


EQUATOR, Arkhangelsk, 2010

EM-4H, Transbaikal, 2007

EM-4H, Yakutia, 2012

GT-MAG, Kazakhstan, 2011

EQUATOR,
Yakutia, Mirny, 2014

EQUATOR, Angola, 2013

EQUATOR,
the Sayan Mountains, 2010

AIRBORNE EM SYSTEM EQUATOR

Electromagnetic time-domain systems are irreplaceable for exploration of large conductive objects.

Frequency-domain systems are very useful for geological mapping or when conductivity contrast between the object and the host rock is not so high.

But what if both are necessary?

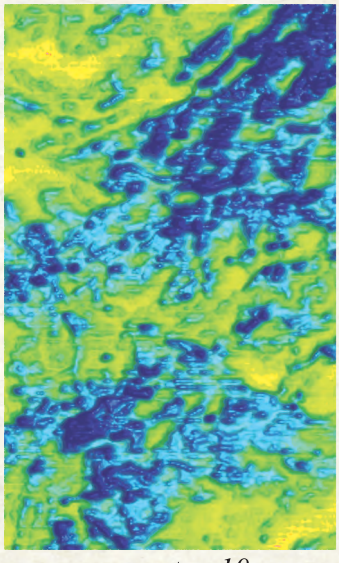
USE EQUATOR!

Like a Joker, EQUATOR will be the system that suits your needs best.

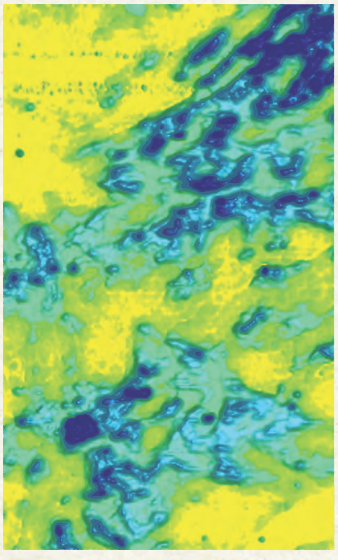
At your desire high-precision airborne electromagnetic system EQUATOR will be time-domain or multi-frequency system or even both simultaneously.

Here EQUATOR is a traditional Time-Domain system

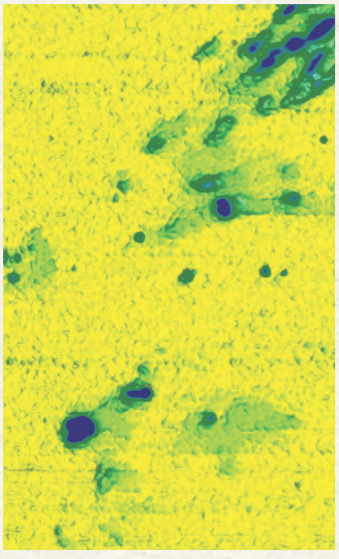
Looking at these maps sounding effect is easily seen: at later times the influence of the shallow sub-surface 'disappears' and deep conductive object 'appears' more clearly.



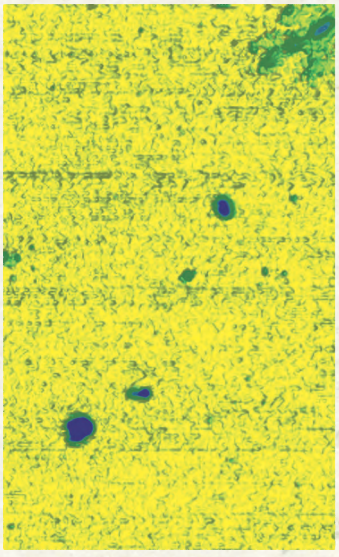
t = 10 μs



t = 50 μs



t = 400 μs



t = 1000 μs

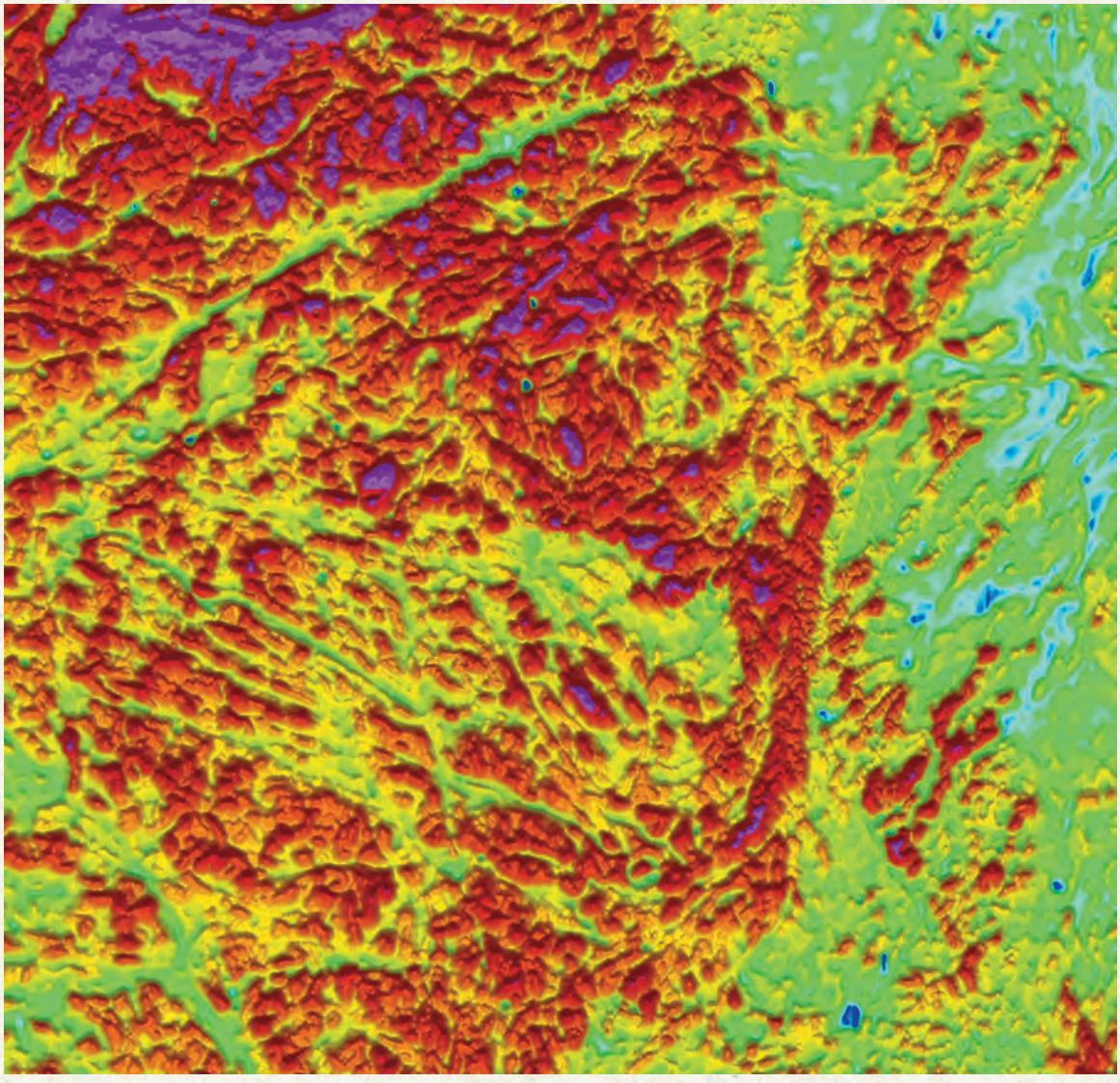
dBz/dt, nT/s

2000 700 30 1

5km 0 5km

Here **EQUATOR** is a traditional frequency-domain system

Faults structure is clearly seen on the frequency map. You can also see local conductive areas. They are associated with reddish crusts and terrigenous material in accumulation zones of paleovalleys and stream ways.



Apparent conductivity map, f = 3 163 Hz

This map and maps on the left page are the results of the same survey. EQUATOR gives you the unique opportunity to see geological results of your survey in different ways.

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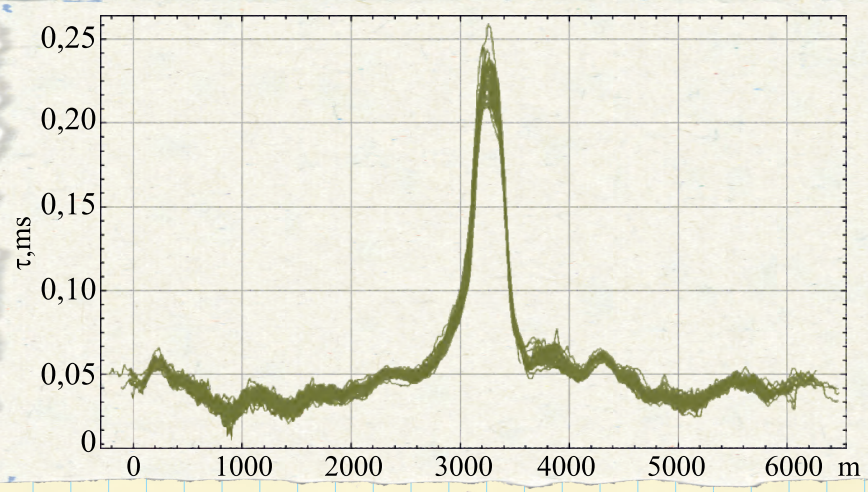
TOO GOOD TO BE TRUE?

We tested, specially for you. It's up to you to decide!

EQUATOR system, stability



Here are time constant (τ) charts calculated for 80 control flights along the same route.

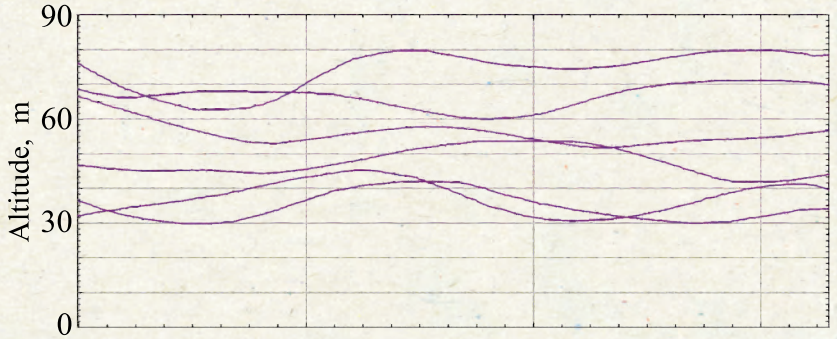
One flight for each survey day.

As it should be all charts are the same!

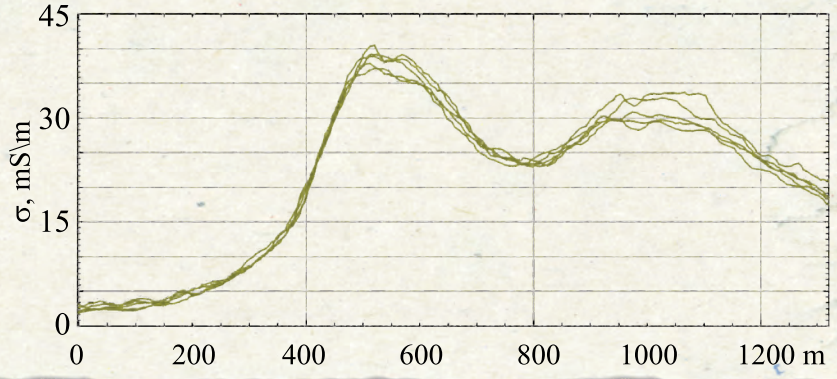
EQUATOR system, invariance

Let's look from another point of view. But no matter how you look at it, conductivity should remains the same from any altitude (if something can be seen, of course).

Here are EQUATOR altitude values for six flight along the same route.

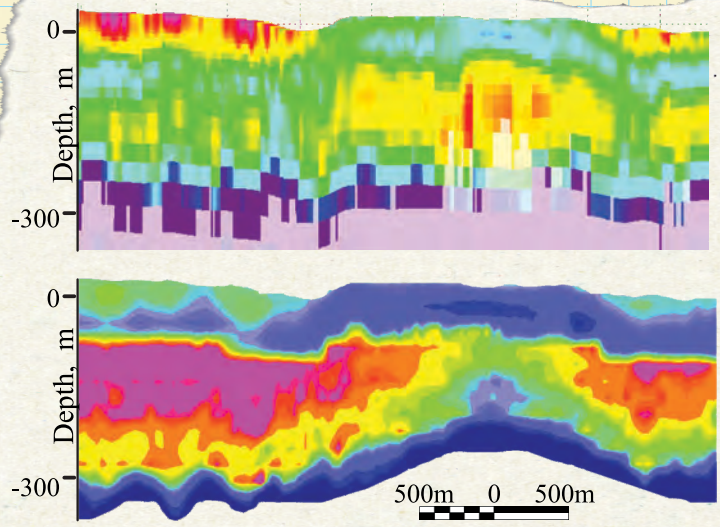


Here are values of apparent conductivity for these six routes.

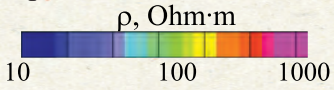


Things change. But quality of measurements should remains high

EQUATOR system, penetration depth

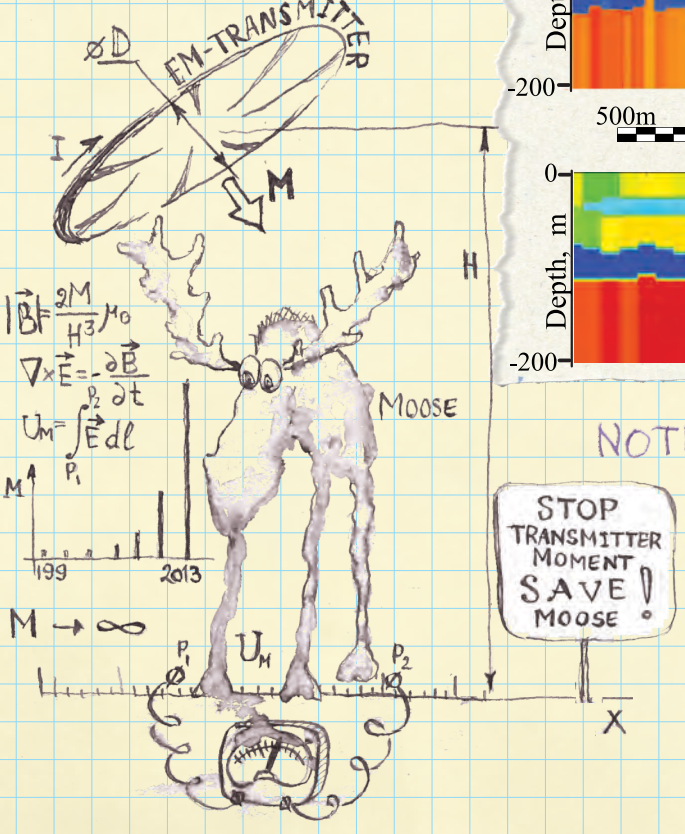


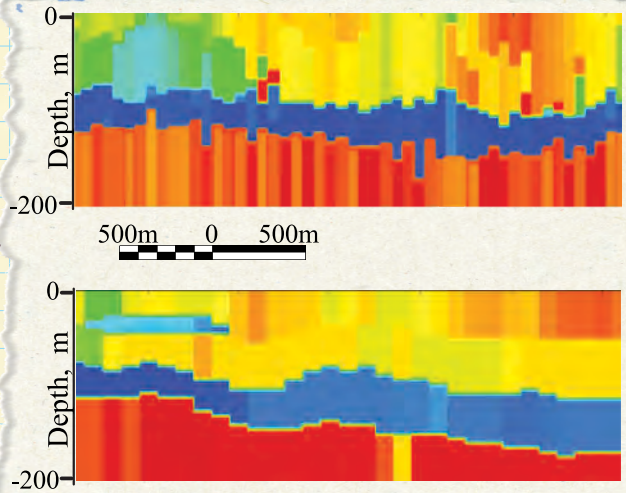
This is 2-D inversion, constructed by Aarhus Geophysics. Under upper quite conductive layers strong conductor at depth of more than 100 metres is clearly seen. For this section traditional time-domain representation of data was used.



And this is an ordinary CDI. To make it we used frequency-domain data representation. It looks similar, isn't it?

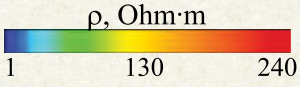
Yes, but... also here is a low-contrast conductive object between upper and lower conductive layers. This is a known kimberlite body.





Another survey.

At the 1-D inversion of EQUATOR data the lower border of conductive layer is clearly seen.



And it corresponds to 1-D inversion of ground EM survey (TEM-FAST system, close profile).

NOTE! EQUATOR transmitter moment is quite small - 100 000 NIA

To achive high detectability and penetration depth we focused on the improvement of receiver sensitivity and signal processing

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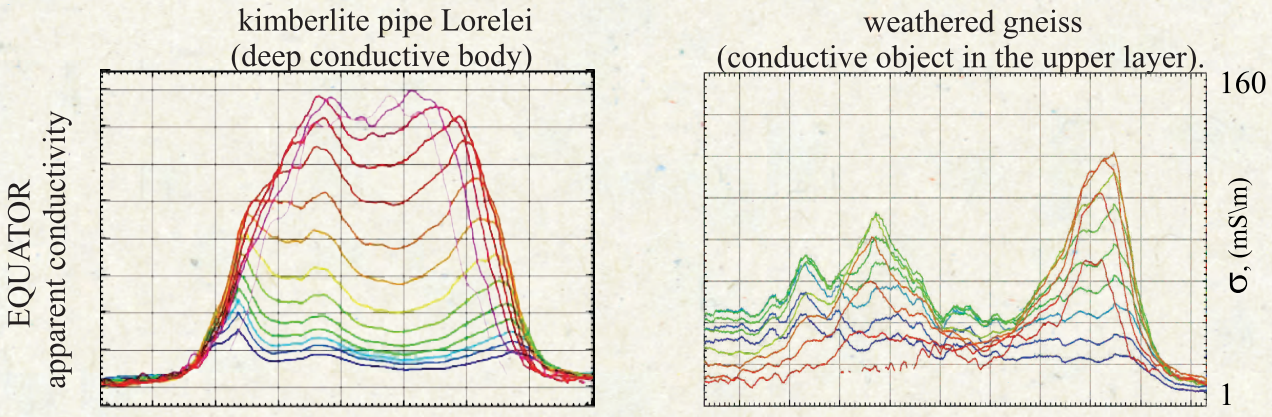
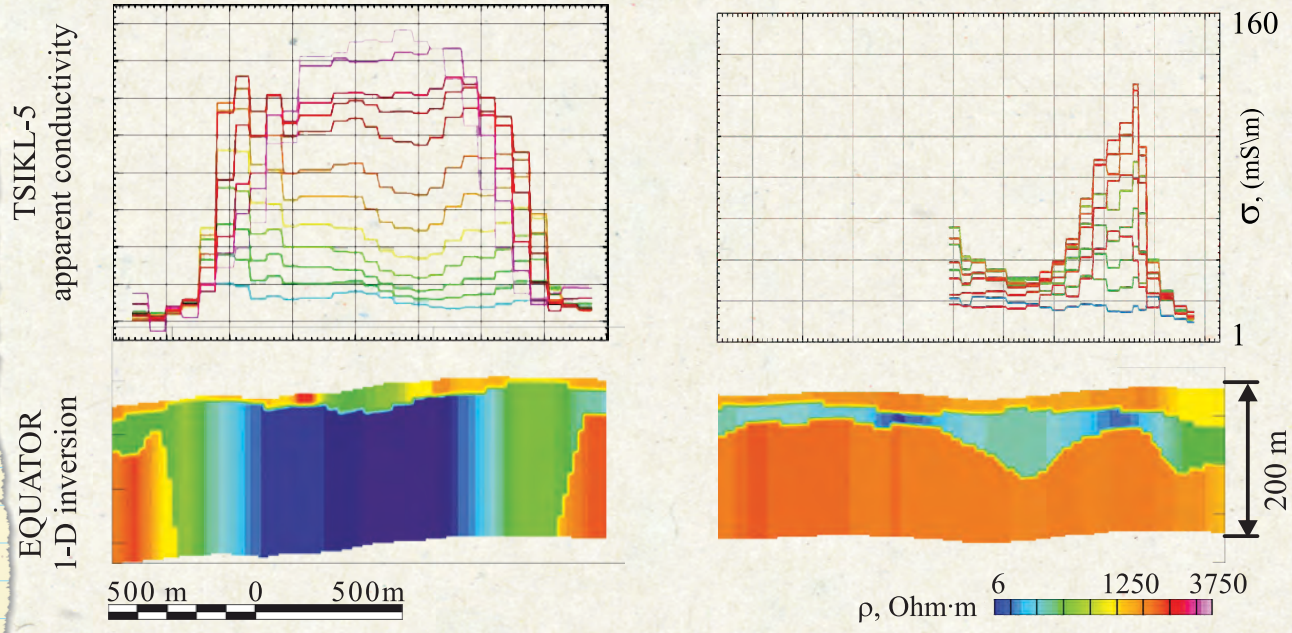
WE LOOKED FOR KIMBERLITES IN ANGOLA AND WE FOUND THEM !

1. We tested EQUATOR system over known objects confirmed by drilling:



2. The results were compared with ground electromagnetic data.

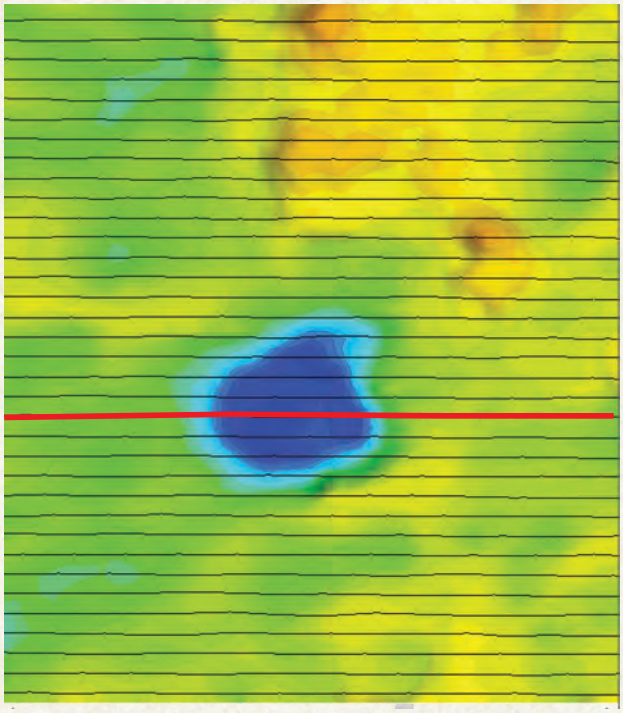


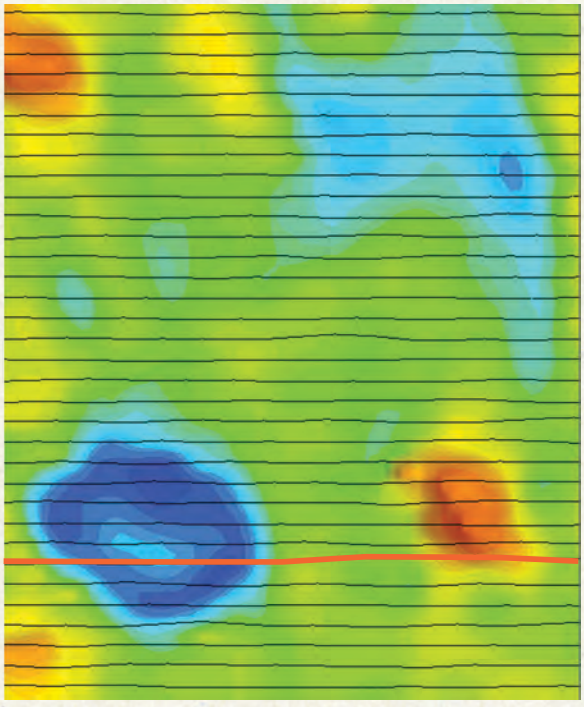
We convinced that

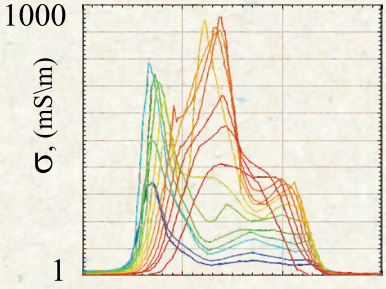
- objects in EQUATOR and TSIKL-5 data look similar
- known kimberlite pipe and shallow conductive body can be clearly distinguished by conductivity distribution at later times and by 1-D inversion.

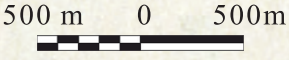
Hurrah! We found known pipe!

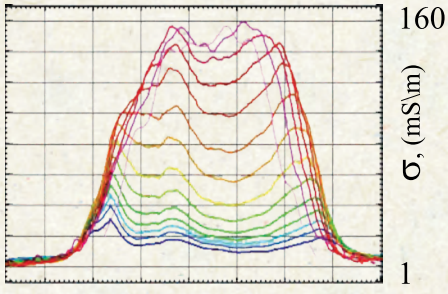
3. Then we proceeded to exploration of new pipes.
Similar objects were founded at the map (on the left there is one of them and on the right there is the test object).



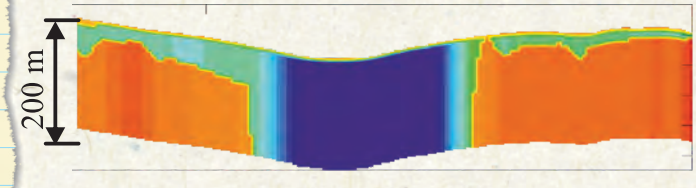


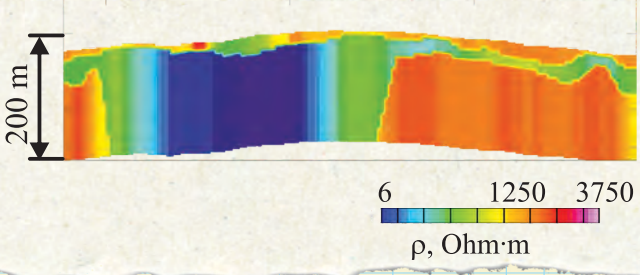






4. To define whether it is kimberlite we used 1-D inversion.





5. The conclusion: The object is similar to test object.

Drilling confirmed: KIMBERLITE

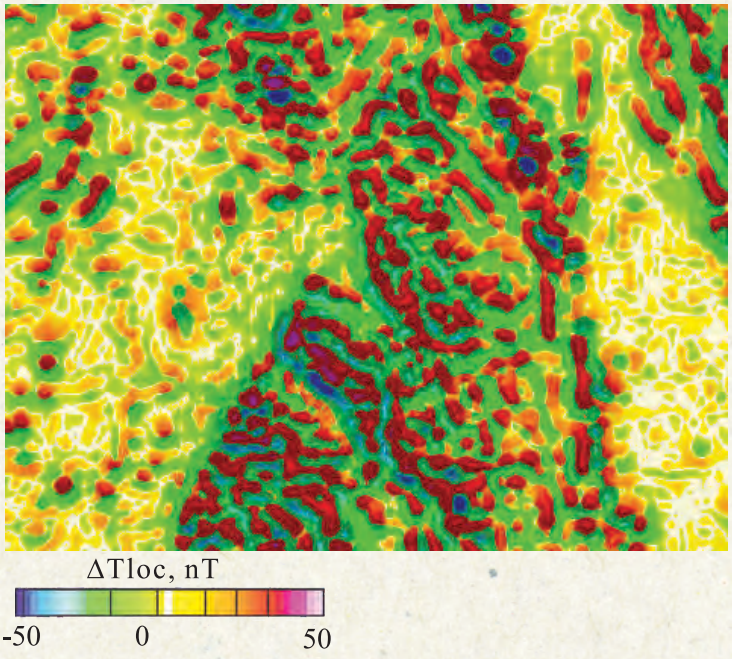
INTERPRETATION EXAMPLE# 1

Task: Kimberlite bodies exploration

Data: „EQUATOR" system

Survey area: Angola

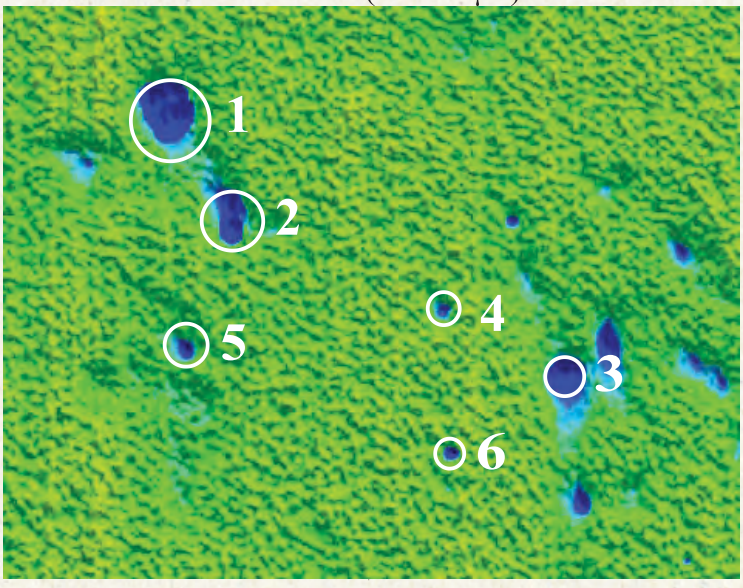
Magnetic anomaly map (local component)



Lets evaluate exploration conditions: Kimberlite bodies sometimes are visible in the magnetic field but here it is rather dissected and can hardly be useful.

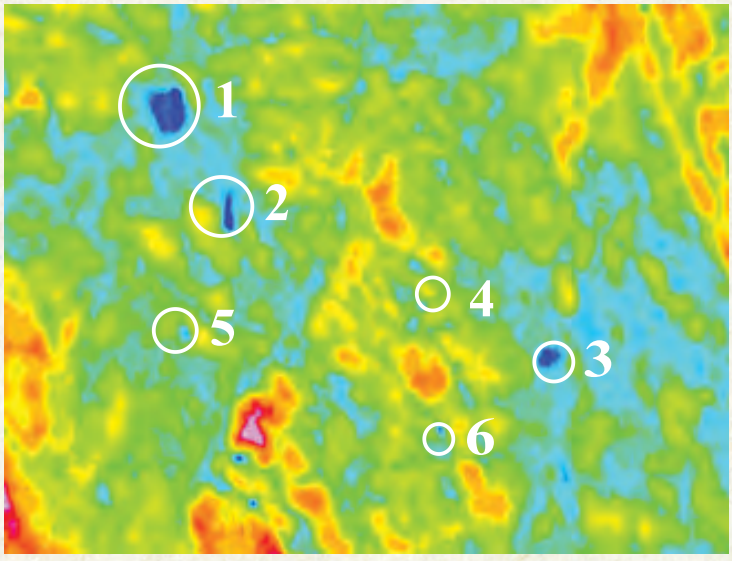
But they are clearly seen in Time-domain signals of EQUATOR system at later times.

dB/dt (t = 400 μS)



These anomalies look like kimberlites!

Apparent resistivity map (f = 3163 Hz)



ρ, Ohm · m

4 700 4000

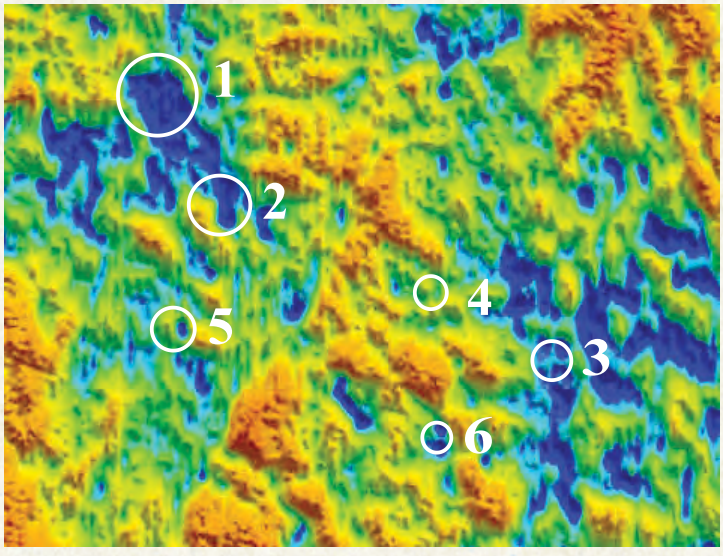
At apparent resistivity map it is clear that upper layers in the survey area are conductive.

Question

A lot of objects are found, but how deep do they lie? How can they be confirmed?

Lets have a look at Time-domain signals at early times.

dB/dt (10 μS)



dB/dt, nT/s

1400 400 0

Now it is clear that objects #1, #2, #3 lie under conductive overburden.

Drilling Results

Objects # 1, #2 and #3 were drilled already - they are kimberlites!

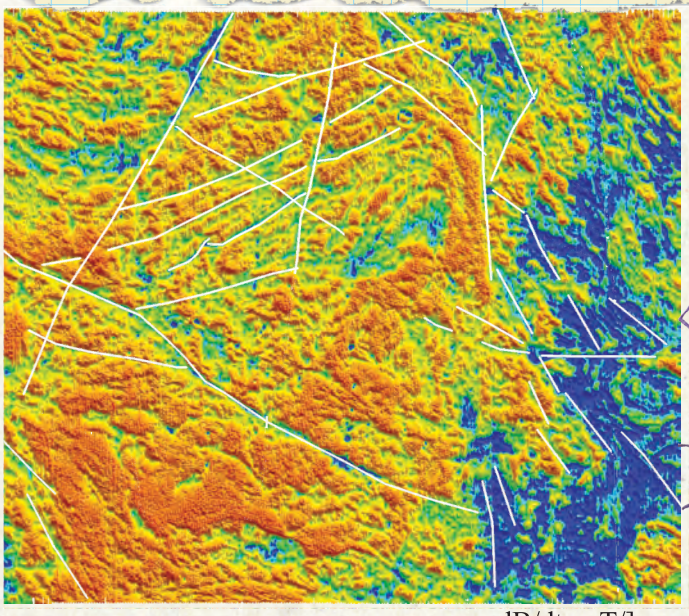
Object # 5 is exposed at the surface!
No need to drill!
Diamonds were found in placer samples.

INTERPRETATION EXAMPLE# 2

Task: Geological mapping

Data: „EQUATOR" system

Survey area: Angola

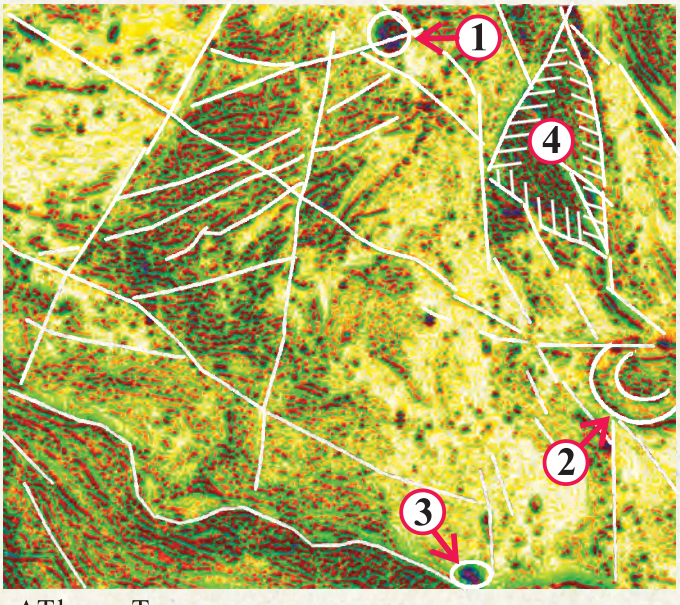


dB/dt, nT/]s

1400 400 0

High resolution at early times lets us identify lineaments (here we used dB/dt map, time gate 5- 10 μs). Comparing the result with relief we can draw fault structure.

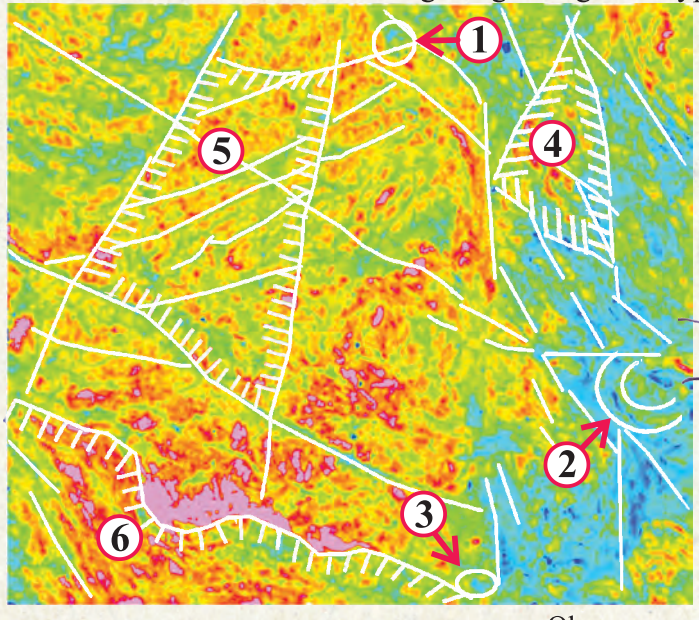
Magnetic anomaly map (local component) gives us additional information.



ΔTloc, nT

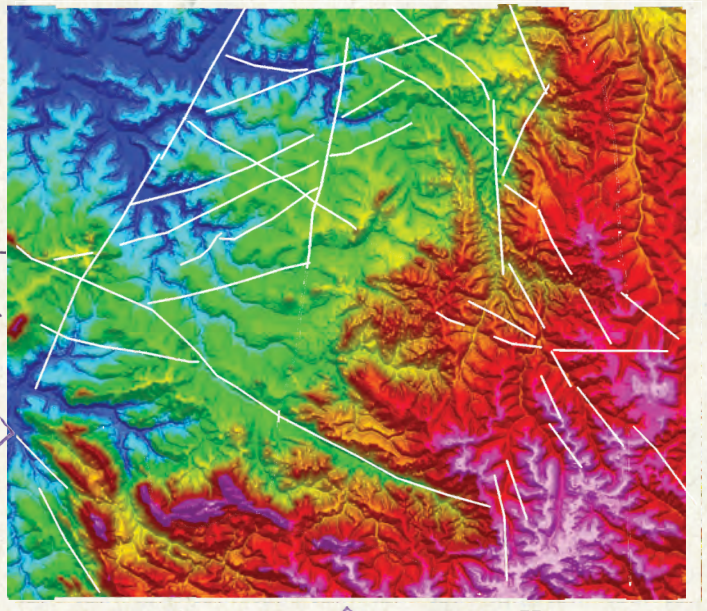
-50 0 50

At apparent resistivity maps (obtained from frequency domain data) areas of different geoelectrical properties are easily seen. High measurement accuracy lets us differentiate even areas of close geological age and type.

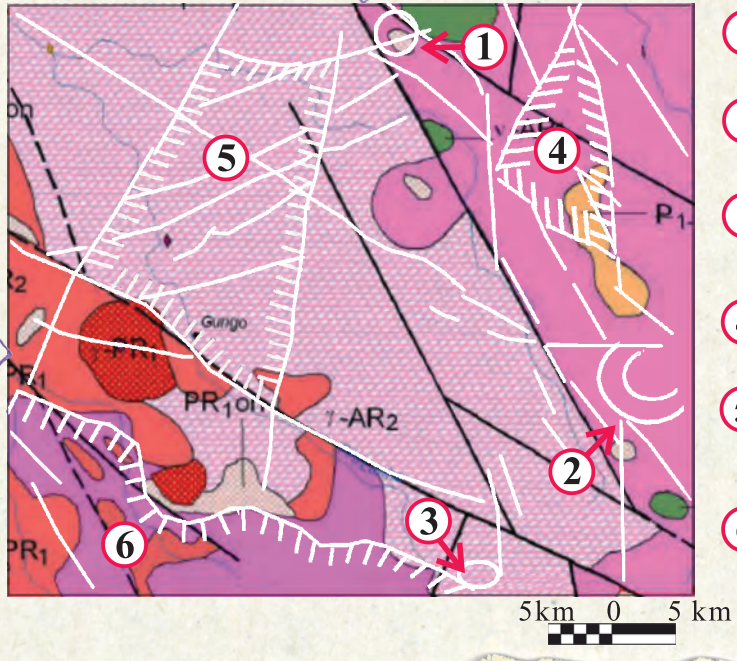


ρ, Ohm · m

4 700 4000



Using all available geological information we classify areas of different rocks type. This allow us to supplement essentially geology map and to make conclusions about mineral deposits localization.



1. Mafic stocks (presumably).
2. The central type structure. It possibly contains PGM-Cu-Ni targets.
3. The local highly magnetic body (1800x1300 m), presumably orebody.
4. Amphibolite bodies.
5. The block of methamorphic shales.
6. The block of Paleoarchean stratify rocks, interchange of crystal shales, quartzites, conglomerates and metagabbro.

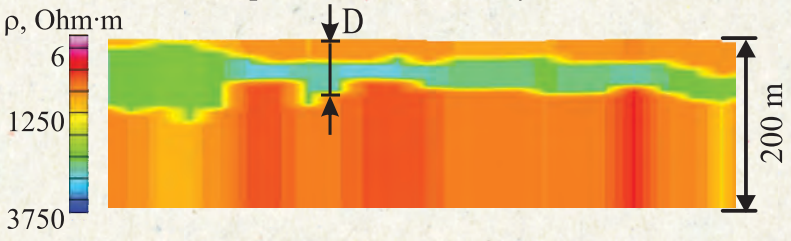
INTERPRETATION EXAMPLE# 3

Task: Placer deposits exploration

Data: „EQUATOR" system

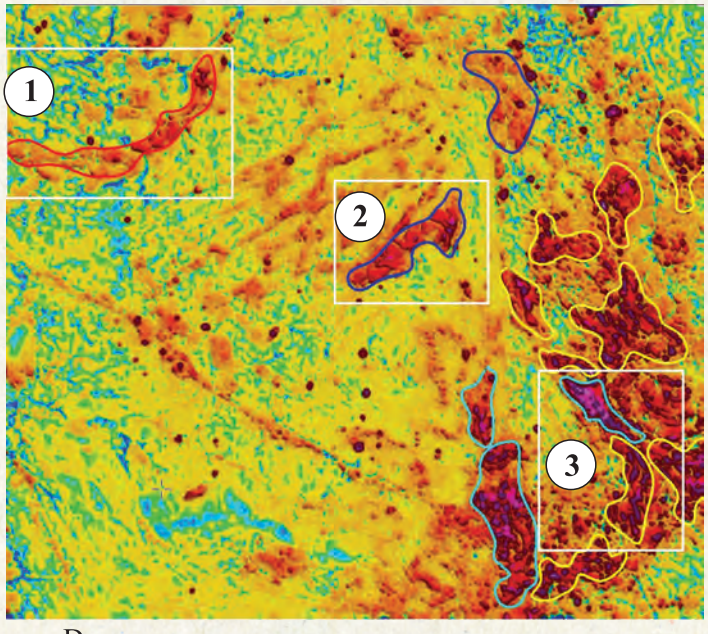
Survey area: Angola

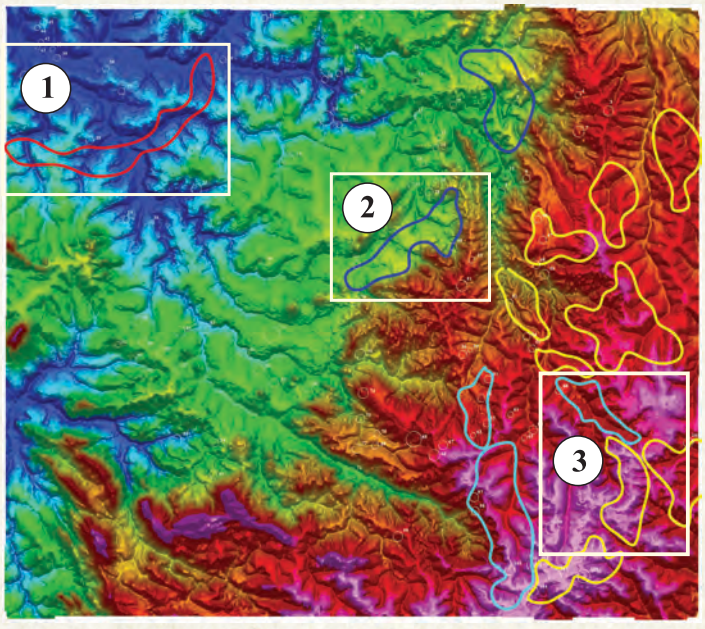
1-D inversion was completed for each survey line.



The lower layer is basement, two upper layers are soft sediments. D designates sediments thickness.

Then D was calculated for the whole survey area and the map of sediments thickness was constructed. Zones with increased thickness were defined and outlined on the relief map.



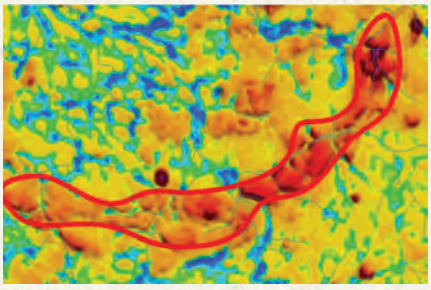


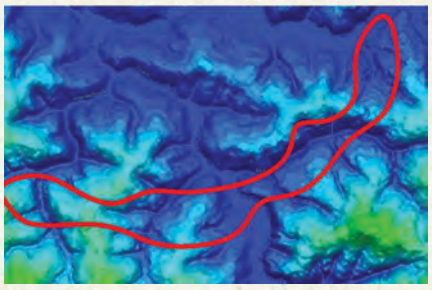
D, m
3 15 70

H, m
1250 1500 1800

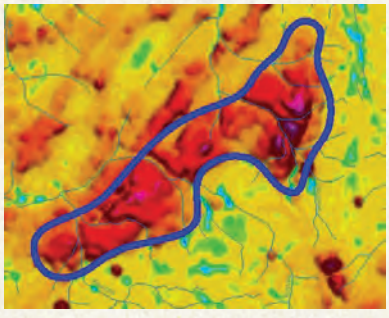
5km 0 5 km

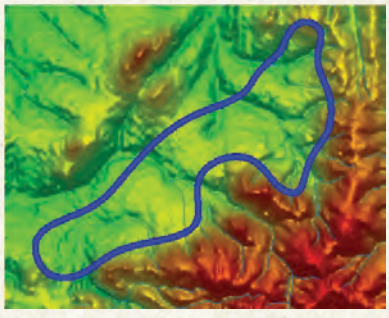
Now it is clear what they are.



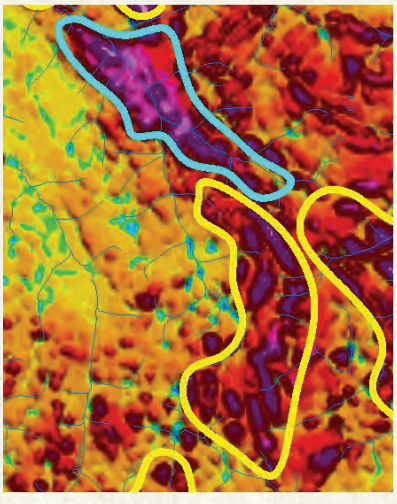


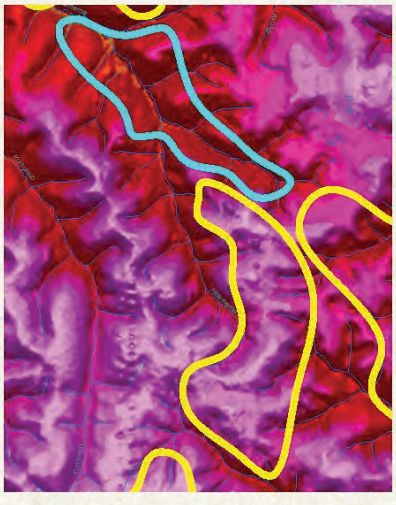
1 Terrigenous sediments accumulated in channels of buried paleovalleys.





2 Accumulation zones in hydrodynamic traps of foothill areas.





3 Accumulation zones in the beds of modern watercourses (blue contour) and on the watersheds (yellow contour).

Taking into account that there are kimberlite bodies at the survey area these zones are perspective for placer deposits.

AIRBORNE INFRARED IMAGING

If there is a hot object underground the surface will be slightly warmer and vice versa if there is a cold object. It is almost unnoticeable, but our thermal scanner will find anything if only there is only a 0.05K temperature difference.

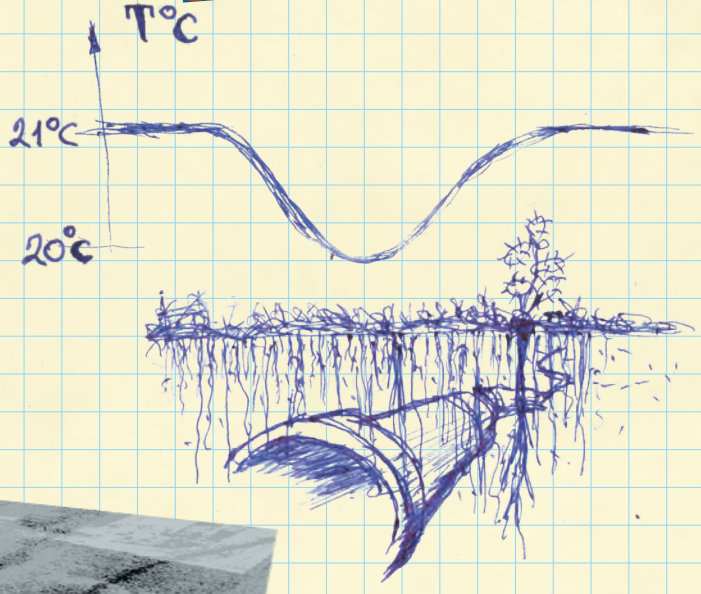
HOT OBJECTS

This hot spot marks damage to an underground heat supply network. There was nothing outside but inside it turns out to be this.

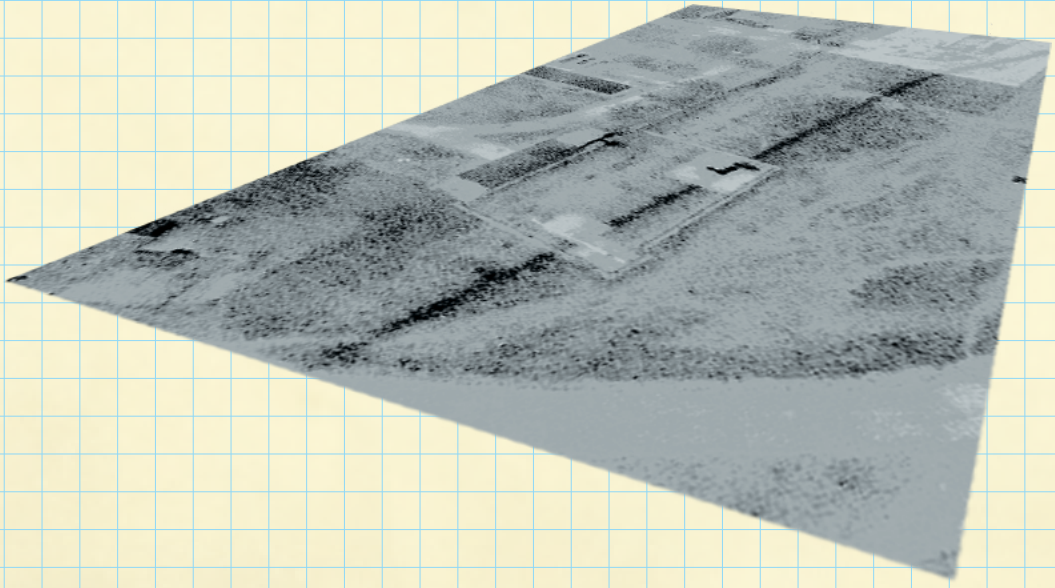
This is a thermal image: white means hot and black means cold.

COLD OBJECTS

While conducting an infrared survey in Mexican outback (January 2011) we found a long cold underground object among swamps, cactus and wild animals.



It turned out to be an ammonia pipeline. Its temperature was just 5°C colder than that of the ground surface.



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