CJSC “Timer”

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The potentialities of ground-penetrating radar in the engineering geology using the radars GROT-12 and GROT-12E

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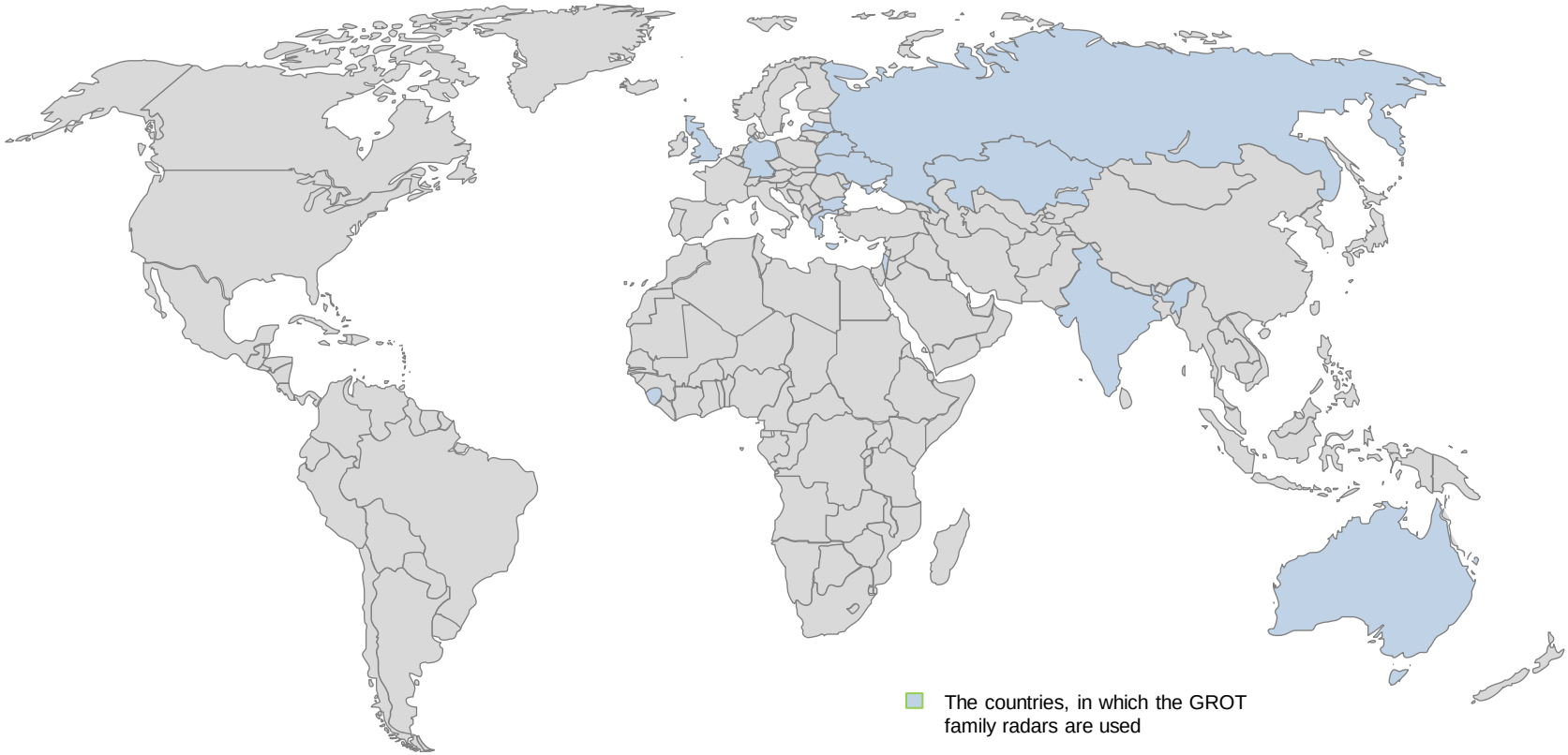
Brief information about CJSC “Timer”



- **CJSC “Timer” was founded in 1997**
- **The head office is situated in Moscow, Russia**
- **The company has clients in more than 10 countries**
- **CJSC “Timer” has 4 patents on several technologies**
- **In 2011 an innovative GROT 12E GPR was launched**

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Application fields of the CJSC “Timer” production

GROT family radars

Ultra wideband optico-electronic equipment

Geology and archeology

Constructional engineering and public service

Oil and gas industry

Ecology

The market requires further developments of our technologies providing higher resolution, deeper exploration depth as well as data interpretation refinement in different media with varying conductivity

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Distinctions of technology used in the GROT 12 GPR family

- **Powerful transmitter, with the most abrupt leading edge, has more than 1MW and ability to adjust the power**
- **Linear digitization without gating**
- **Antennas provide a short aperiodic pulse**

Maxwell's equations describing the propagation of impulse electromagnetic signals in real media

$$\mathrm{div}\mathbf{B} = 0$$

$$\mathrm{div}\mathbf{D} = 0$$

$$\mathrm{rot}\mathbf{H} = \frac{1}{c}\frac{\partial \mathbf{D}}{\partial t} + \frac{4\pi}{c}\mathbf{J} \quad \mathrm{rot}\mathbf{E} = -\frac{1}{c}\frac{\partial \mathbf{B}}{\partial t}$$

$$\mathbf{B} = \mathbf{H}$$

$$\mathbf{D}(t) = \mathbf{E}(t) + \int_0^\infty f(\tau)\mathbf{E}(t-\tau)d\tau$$

The modeling of the function f(τ) for a real medium

$$\varepsilon(\omega,\mathbf{r}) = \varepsilon_0(\mathbf{r}) + i\sigma(\mathbf{r})\omega$$

Quasistationary condition

$$\varepsilon_0 \frac{\partial^2 E}{\partial t^2} << \frac{\partial^2 E}{\partial x^2}$$

Wave equation

$$\varepsilon_0 \frac{\partial^2 E}{\partial t^2} + \sigma\frac{\partial E}{\partial t} - \frac{\partial^2 E}{\partial x^2} = 0$$

Ground-penetrating radar

Heat equation

$$\frac{\partial E}{\partial t} = \sigma^{-1}\frac{\partial^2 E}{\partial x^2}$$

Electrical exploration

$$\varepsilon(\omega,\mathbf{r}) = \varepsilon_0(\mathbf{r}) + i\sigma(\mathbf{r})\omega$$

$$D(t,x) = \varepsilon_0 E(t,x) + \sigma\int_0^\infty E(t-\tau,x)d\tau$$

We simulate the functionf (τ)and verify the quasistationary condition for a real medium

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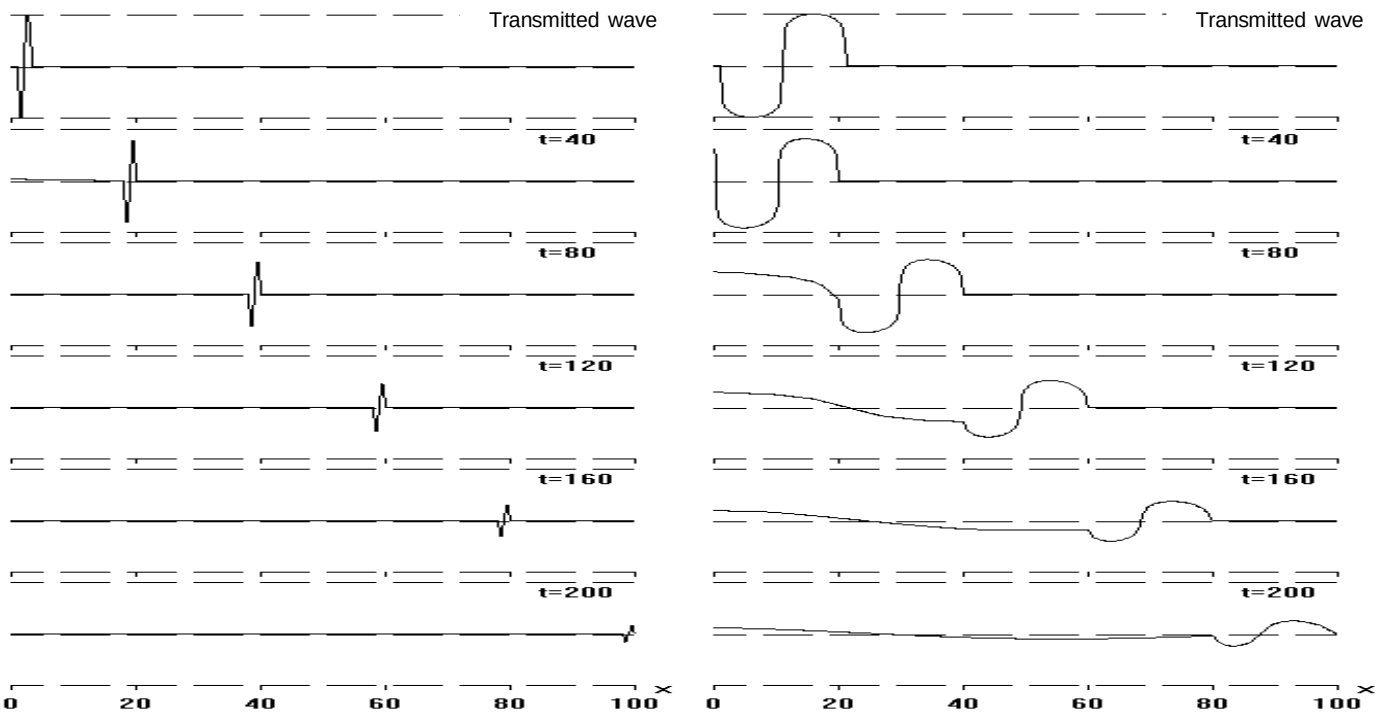
Computation of the signal propagation in dielectric, considering dispersion with dependence on conductivity

The propagation of signals with transmitted wave periods
T=4 (on the left) and T=40 (on the right)

$\varepsilon_0 = 4$

$\sigma = 0.25$

Quasi-logarithmic scale



The signal propagation with attenuation but without shape distortion when σT≤1 transforms into the typical propagation with attenuation in the skin depth of the conductor if σT>>1

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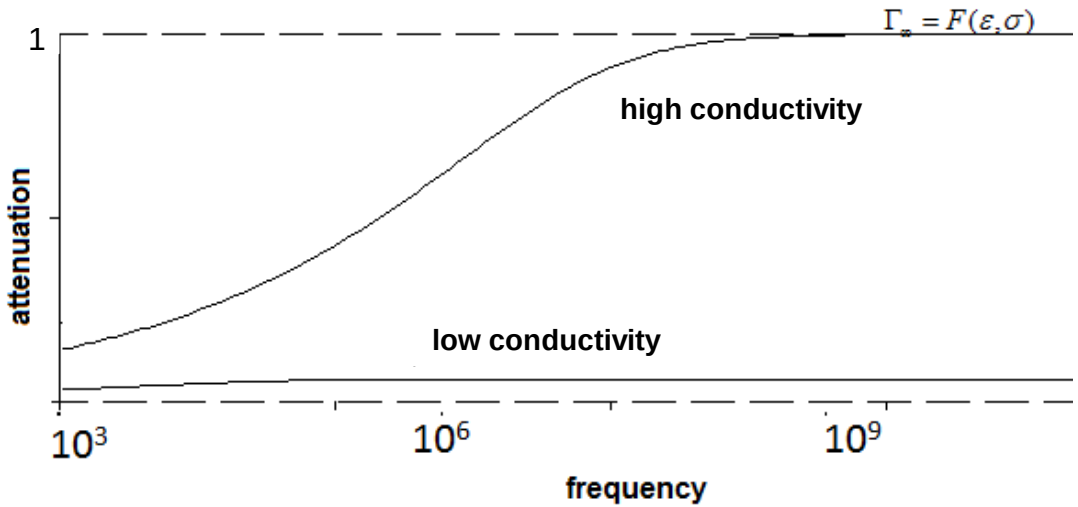
The depth range of ground-penetrating radar



Hz

The length of antennas is determined by the conductivity of the medium

- The conductivity of a medium, which stands in the wave equation as σ, determines dissipation of wave energy and therefore the potentialities of ground-penetrating radar.
- At low frequencies attenuation depends on frequency, and it can be tiny as possible, when the frequency becomes lower. But at such frequencies the wideband signals undergo dispersion or a shape distortion.
- At high frequencies the attenuation can be considered as not depended on frequency so the pulse amplitude reduces without shape distortion.

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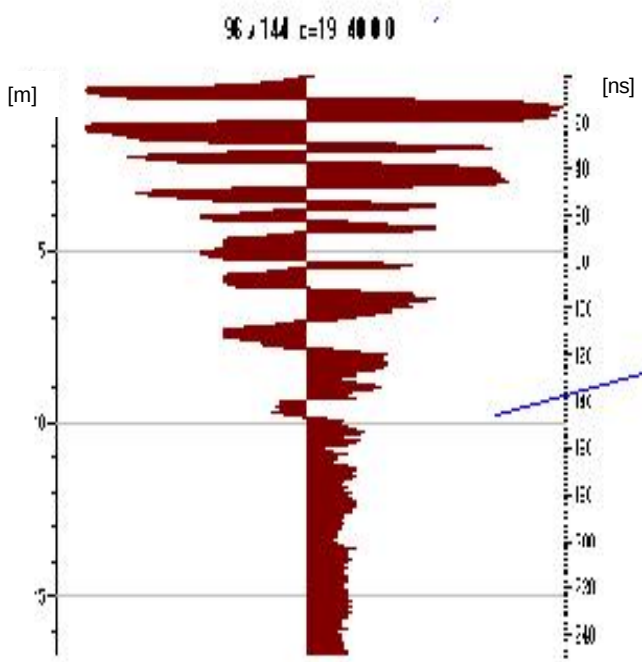
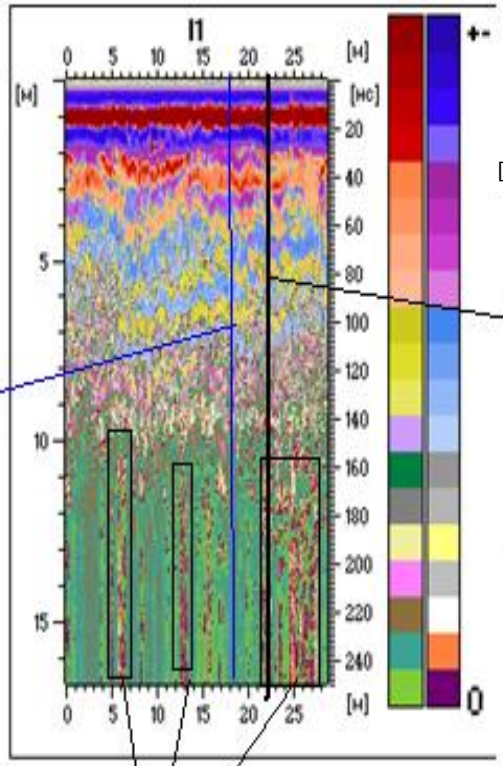
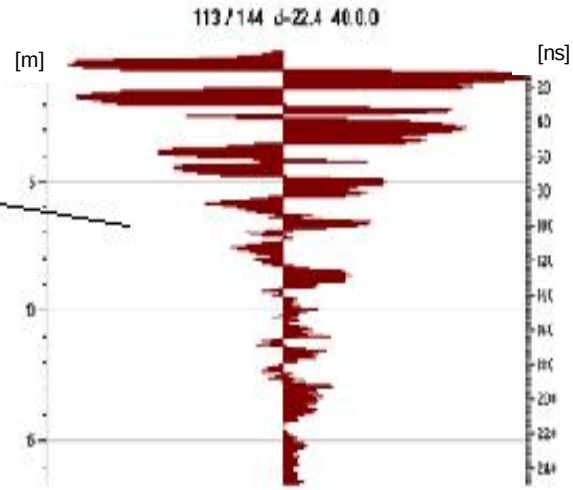
The impact of the medium dispersion: the study of oil pollution in Voronezh, Russia

Not polluted area





Polluted area



The oil leakages

It was proved that oil polluted areas can be detected with GPR for ecological purposes

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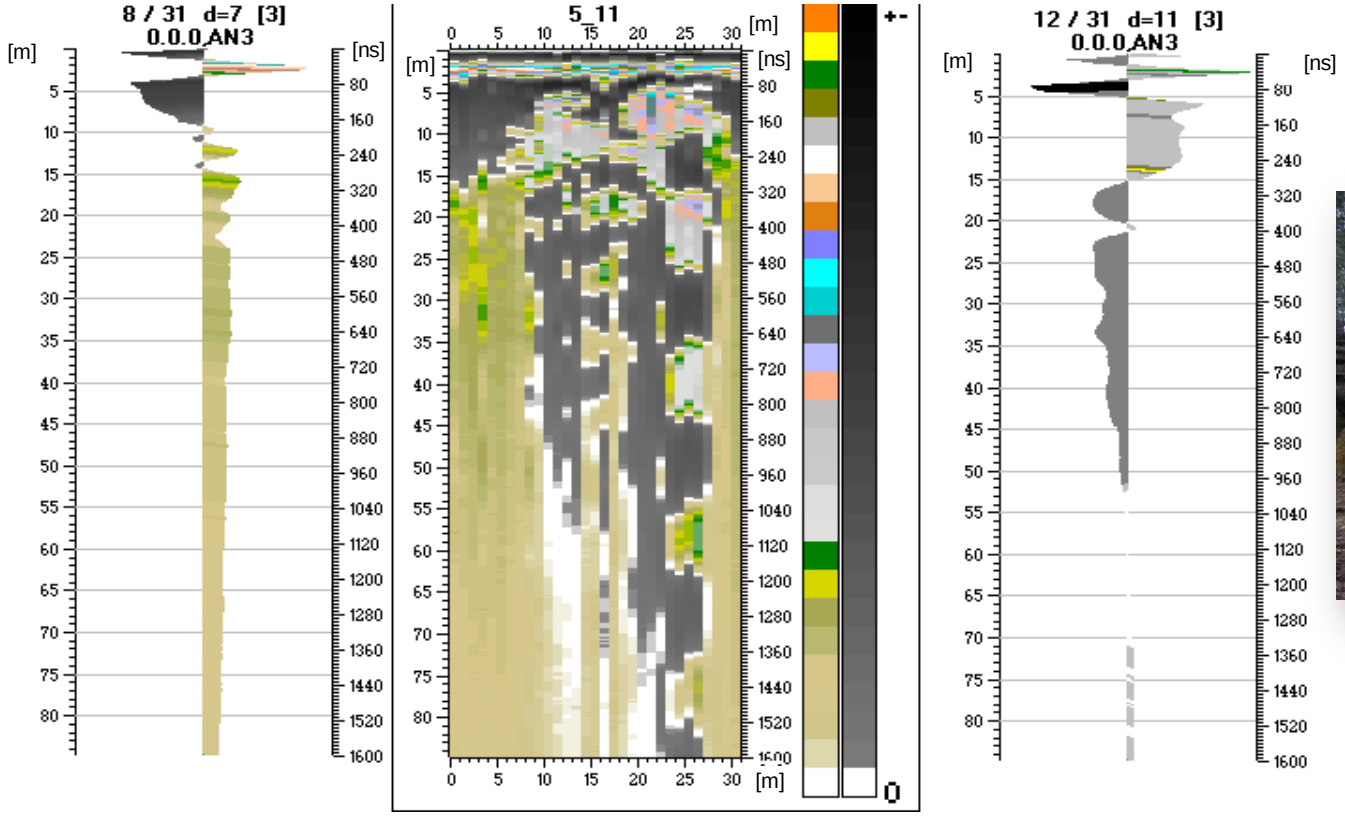
The impact of the medium dispersion: the investigation of a goldfield in Hargraves, Australia



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It was proved that the quartz-based gold deposits can be detected and contoured down to 80 meters in depth using 4 meter long antennas

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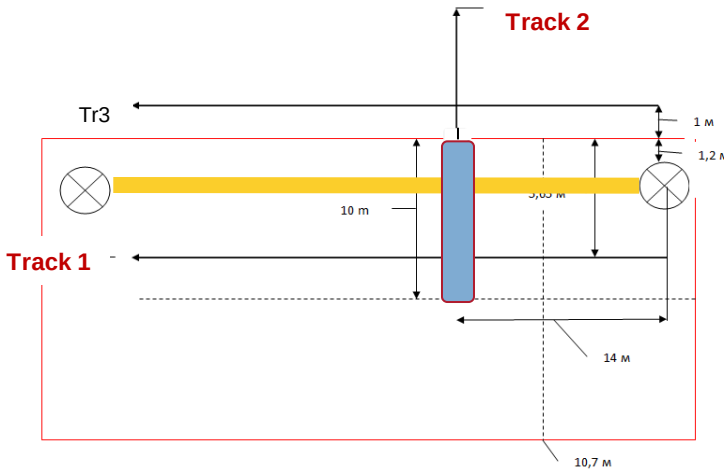
Examples of practical usage of GROT 12 GPR family

Specifications of GROT 12 and GROT 12E

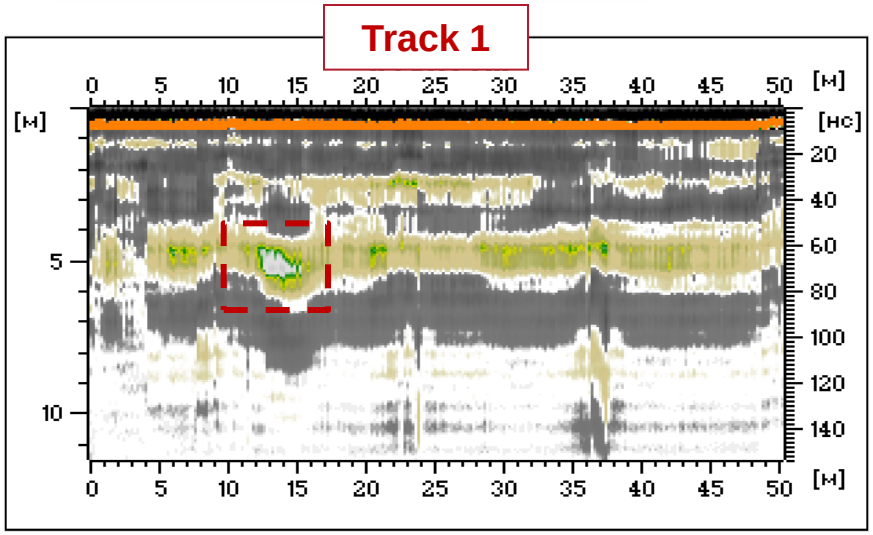
Localization of the service lines under the reinforced concrete surface in airports

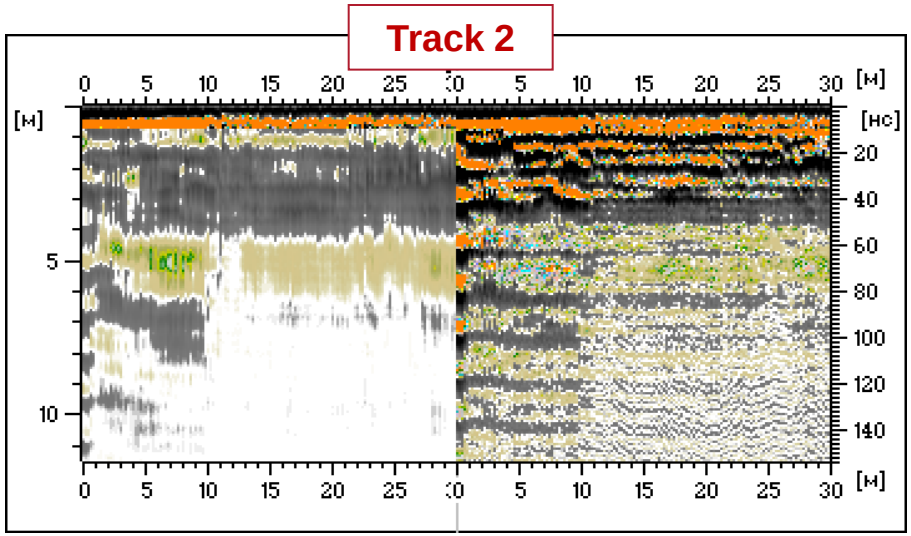
Sheremetyevo airport, Moscow, Russia, 2012

Sewer manhole, diameter 0.7 m
Tracks
Slits in the concrete
Takeoff strip
Detected anomaly
Drain pipe



GPR tracks scheme





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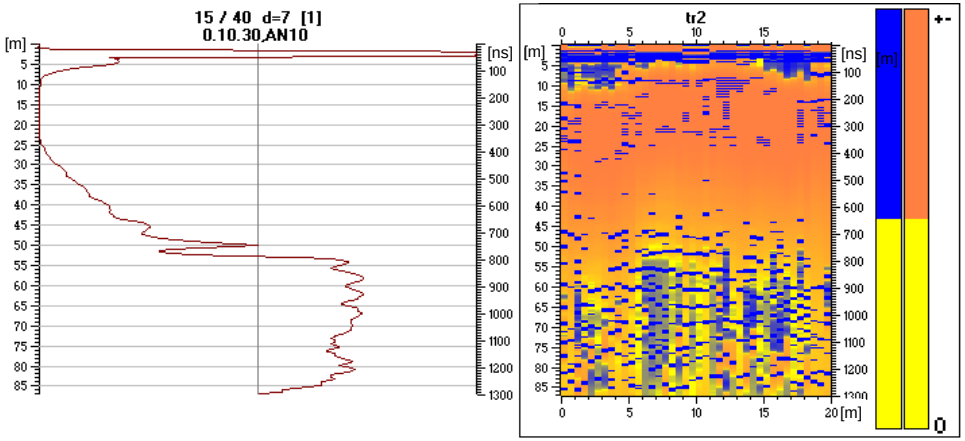
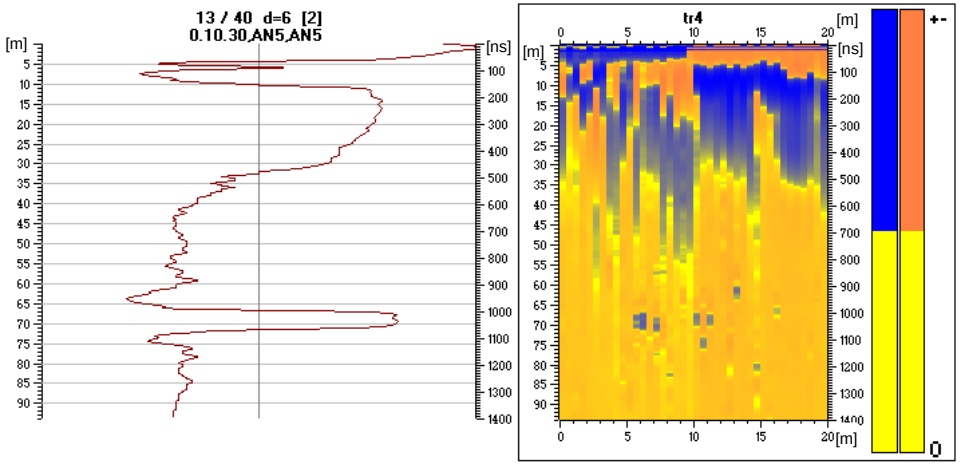
Localization of the reinforced concrete tunnel in the water intake structure, Sydney, Australia



Detection of the tunnel under a concrete plate at the depth of 40 meters



Detection of the tunnel at the depth of 70 meters !

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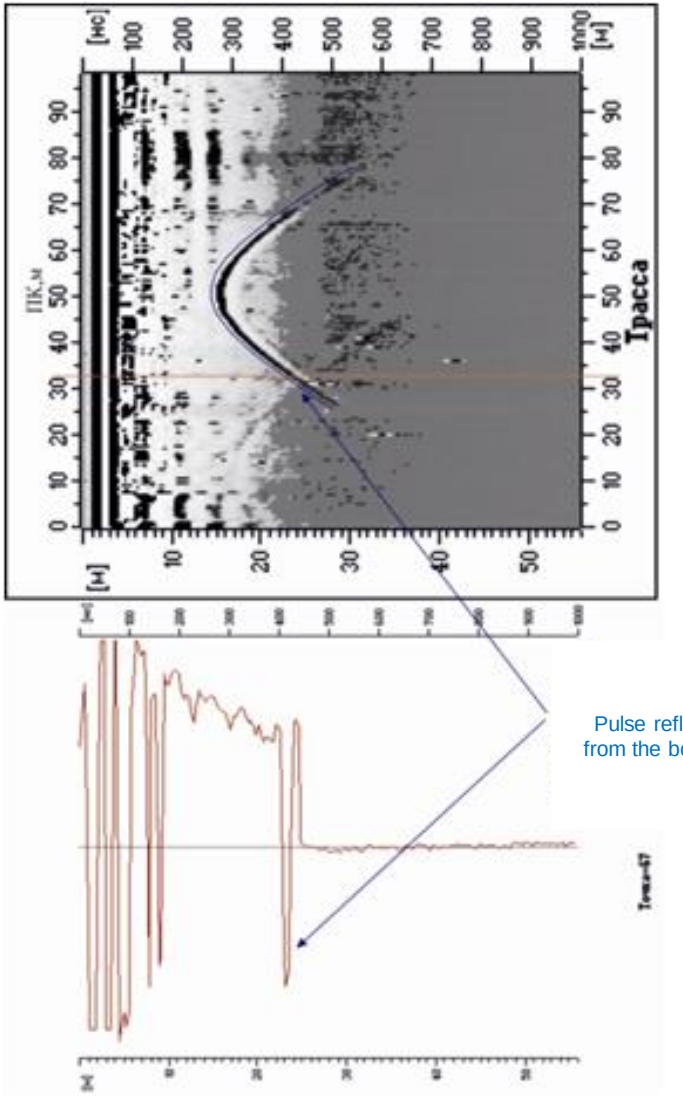
Localization of boreholes in the mines of Solegorsk, Belorussia, in collaboration with JSC “Belgorhimprom”



It is proved that boreholes with diameter less than 0.1 m can be detected

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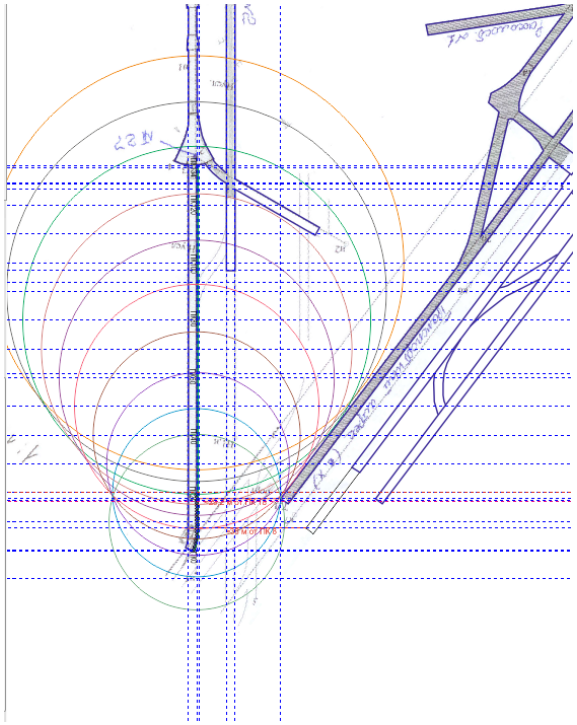
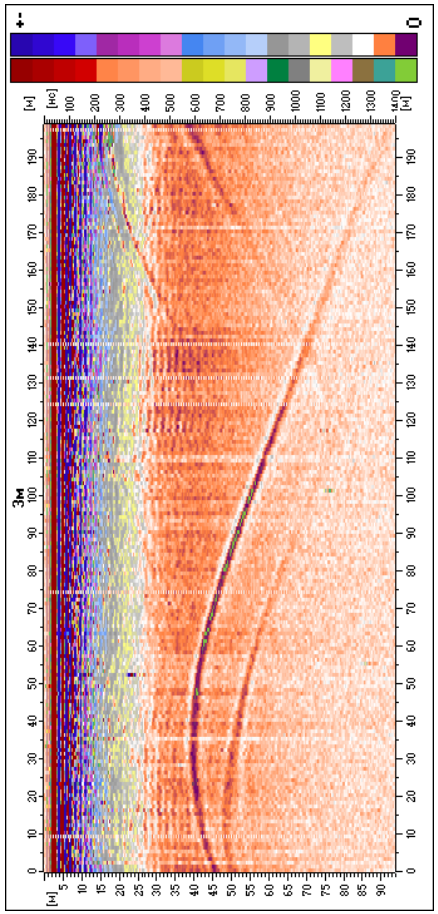
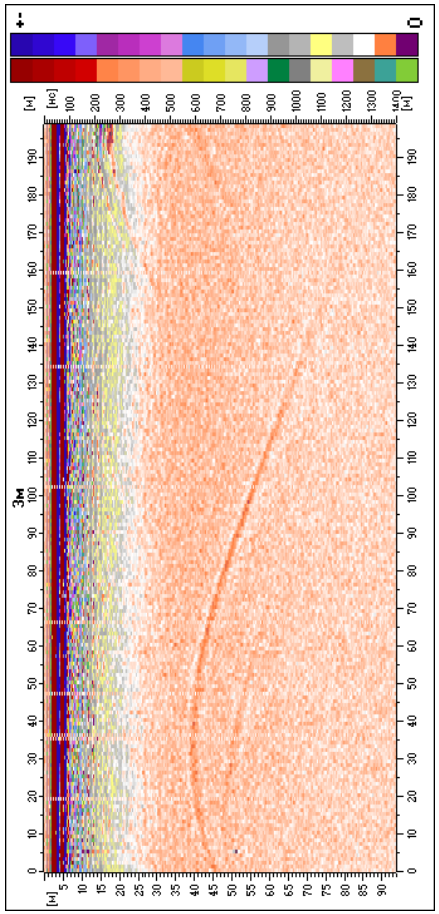
Detection of the flooded abandoned mines in Solegorsk, Belorussia, in collaboration with JSC “Belgorhimprom”



Transmitter power 1MW



Transmitter power 0.1MW



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The transmitter power has a considerable impact on the depth range of ground-penetrating radars

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Specifications of GROT 12 and GROT 12E

	GROT-12	GROT-12E
Frequency Range, MHz	1 - 200	50-500/100-1500
Energy potential, dB	≥140	≥120
Transmitter power, MW	from 0.05 to 10	from 0.05 to 10
Average power, W	< 1	< 1
Range of recorded time delays, ns	10240	32000
Input resistance, Ohm	100	100
The length of the pulse, ns High-frequency version Low-frequency version	 5 20	 1 5
Sensitivity, mV	≥100	≥50
Operating temperature range, ℃	-20 +50	-20 +80
Power consumption, W	≤3	≤6
Weight of the GPR with batteries, kg	≤3,5	≤3,5
Processing in real time, s	< 1	< 1
PC control	RS232,USB,Ethernet, Bluetooth	RS232,USB,Ethernet, Bluetooth

The GROT12 is easily packed and placed into a small case and a pouch for the antennas

- The key advantage of the radars of the GROT12 family is the direct digitization of the received signal without additional operations of gating and frequency conversion, as well as the usage of ultra wideband antennas.
- The GROT 12 radars excel other ground-penetrating radars in their portability, improved measurement accuracy and longer battery life as well as ability to reach the depth of more than 100 meters, while probing high-conductive soils.
- All the GROT 12 family radars are safe for health.

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Partners of CJSC “Timer”

The goal of CJSC “Timer” is development and application of innovative technologies to raise competitive capacity of our partners.

Thank you for your attention!

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