



AIRBORNE GPR

APPLICATIONS AND PRACTICAL CONSIDERATIONS

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The most important parameter of the GPR system is the center frequency. In general, it defines the maximum penetration (if the power of impulse doesn't exceed allowed limits in most countries) and also resolution and capability to detect objects of a certain size.

Below is a summary of what we can expect from the GPR systems available for use with drones and their recommended applications.

Please note that the actual penetration in certain places depends on dozens of factors – composition of the soil, humidity, temperature etc. In the table below, we used the parameters of a typical “average soil” – some substance with the relative dielectric permittivity of 9, low conductivity, almost dry.

Due to the fact that in case of airborne use (when GPR antenna is not in contact with the surface) a significant part of GPR impulse energy can be reflected back from the surface, expected penetration from a drone is half of that achieved with terrestrial survey on the surface.

Recommended altitude (or the distance between the antenna and the surface) in case of airborne survey should be less than the length of EM wave in the air corresponding to the center frequency of the antenna.

Penetration in good conditions like very dry sand in desert after the dry season can be up to 2 times better.

In ideal conditions (snow and ice) penetration can be 3-4 times better (for Cobra Plug-In the maximum penetration in ice limited by the maximum time range of the radar will be approximately 65m for SE-150 and 130m for SE-70 and SE-40).

Conditions like dry sand or snow/ice are also very good for airborne use: if the recommended altitude is maintained we don't see any significant degradation of maximum penetration.

GPR ANTENNAS COMPARISON OF SPECIFICATIONS AND APPLICATIONS

Center frequency, MHz	1000	500	124	80	52
GPR antenna	RadSys Zond-12e 1000A	RadSys Zond-12e 500A	Radarteam Cobra Plug-In SE-150	Radarteam Cobra Plug-In SE-70	Radarteam Cobra Plug-In SE-40
Penetration from surface, m	1..2	4..10	15..20	20..40	40..60
Penetration from the drone, m	0.3..0.5	2..5	7..10	10..20	20..30
Penetration from the drone in freshwater, m	0.1	0.25	6	10	15
Recommended maximum distance between the antenna and the surface for airborne survey, m	0.3 (practical limit is 0.6m)	0.6	2.4	3.7	5.7

Minimum size of detectable objects under surface from the recommended altitude, cm	7	10	40	63	96
Minimum size of “deep” detectable objects from the recommended altitude	11cm at 0.5m	26cm at 2m	94cm at 7m	1.37m at 10m	2.57m at 20m
Minimum diameter of detectable linear conductive objects like a metal pipe or a water-filled plastic pipe, cm	4	8	32	50	77
Minimum size of detectable linear non-conductive objects like an empty plastic pipe, cm	5	10	40	63	96
APPLICATIONS					
Small object Search	Y	Y			
Glaciology, snow/ice thickness profiling		Y	Y	Y	
Geological stratigraphy <ul style="list-style-type: none"> ● subsurface stratigraphy ● structure ● bedrock surface 		Y	Y	Y	Y
Geotechnical surveys <ul style="list-style-type: none"> ● cavity search ● sinkhole search 		Y	Y	Y	Y
Utility search <ul style="list-style-type: none"> ● cables ● water & sewage pipes ● gas pipes ● oil pipes 		Y	Y		
Underground infrastructure mapping		Y	Y		
Archaeology <ul style="list-style-type: none"> ● artefacts 	Y	Y			
Archaeology <ul style="list-style-type: none"> ● foundations ● caves ● tombs ● tunnels 		Y	Y	Y	Y
Forensics		Y	Y		
Freshwater Bathymetry			Y	Y	Y
Mining & Quarrying <ul style="list-style-type: none"> ● rocks ● fractures ● faults ● joints 		Y	Y	Y	Y

SOME PRACTICAL CONSIDERATIONS:

- The minimum size of a detectable object is the size of the top flat surface of an underground object oriented horizontally. It is not possible to detect a sheet of metal even twice the minimum required size if, for example, it is positioned at a 45-degree angle.
- “Minimum size” or “Minimum diameter” means that you are extremely unlikely to detect smaller objects. But it is not *guaranteed* that it will be possible to detect bigger objects – that will depend on dozens of other factors.
- NEVER plan surveys using estimations close to the limits of penetration, size of detectable objects etc. Always use more conservative values.
- A typical mistake of new GPR users is ordering GPR system with maximum penetration and trying to detect smaller subsurface objects with it. Remember – good maximum penetration means poor resolution/capability to detect small objects.
- When ordering a new GPR system for a particular application please consider what penetration is actually necessary, i.e. do not exceed it too much. Very often potential customers ask for a system for utility search with maximum penetration of up to 20m. However, the usual depth of pipes/cables is 1-2m. It’s much better to order a 500Mhz system and thus have the possibility to detect smaller/thinner objects.
- A clay layer with even a little amount of water will ruin acquired image. If there is clay or clayey soil in the survey area it is needed to plan survey after a dry season/long period of dry weather.
- Electromagnetic waves don’t penetrate through saltwater. So GPR can’t be used for sea/saltwater bathymetry.