Application Note
- Using the RAMAC RTC

Description of problem

Geological knowledge from deep structures is most often needed when planning groundwater resources or out-takes of raw material for constructions. In this case the use of low frequency radar systems can be both cost-effective and efficient to accomplish more knowledge of the subsurface conditions.

If the radar antennas are used in normal, broadside, configuration, quite wide paths have to be prepared in the investigation area and at least two people have to be involved in the data collection. This Note will discuss applications were an in-line configuration may be effectively used, and show examples of data.

Equipment used

The RAMAC low frequency system RTC (Rough Terrain Concept) comprises an unshielded 50 MHz antenna (the RAMAC RTA) and CUII control unit, together with the Monitor CV11 for data acquisition.

The RTA within a plastic waterproof pipe.

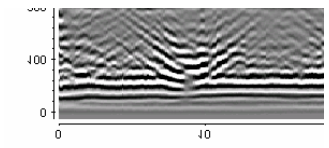
Investigation method

As the RTA antenna is built in one piece, in in-line configuration, it is very straightforward to carry out field investigations even in rough terrain. Clearings of measurement lines are most often unnecessary; where the operator can walk, the antenna will follow. The antenna can of course also be attached behind a vehicle or boat, depending on the investigation type.

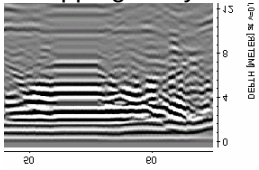
The distance and by that the position, is managed with a hip chain encoder. If measuring long lines (>100 m) it is advisable to re-attach the cotton string for appropriate distance measurements. The position can of course also be governed by a GPS, connected directly to the Monitor. However, it should always be kept in mind that the measuring point is centred between the two antenna electronic units.

Critical elements

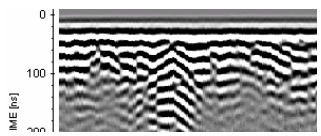
As the RTA antenna is an in-line configuration, the polarization as well as the antenna radiation pattern makes close range detection somewhat more difficult. However, when mapping layers and other non-polarizing targets, especially deeper ones, there is little difference between the two configurations. The differences are shown in the pictures below, both the mapping of an object and the mapping of layers.



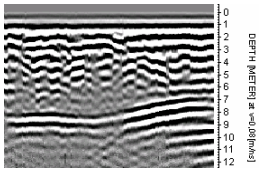
Hyporbola Broad-side



Layer Broad-side



Hyporbola In-line

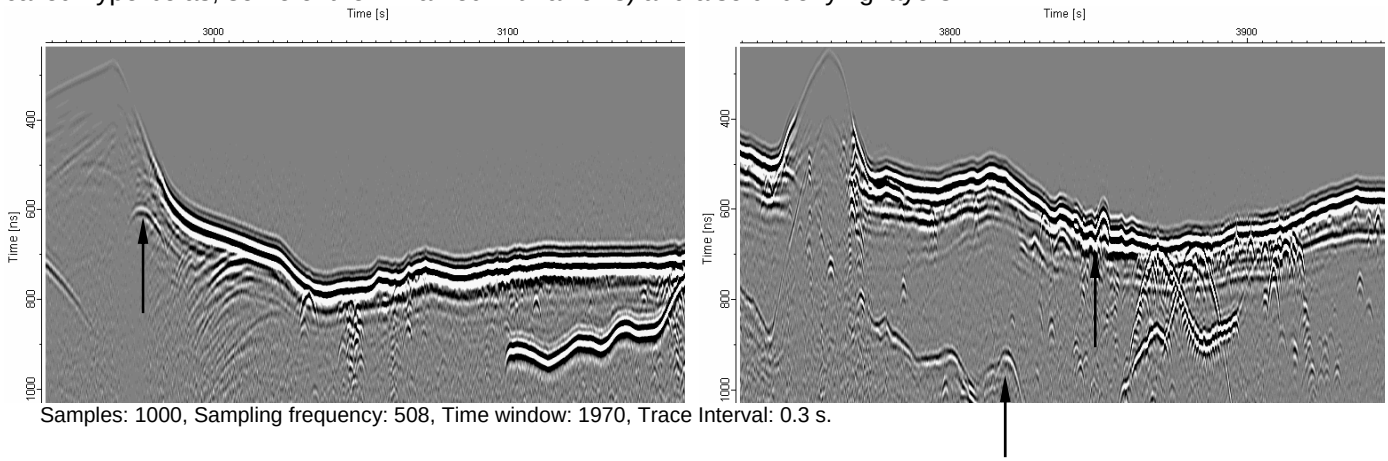


Layer In-line

As the RT is an antenna of unshielded type, unwanted noise can also occur in the data, due to the fact that the antenna emits electromagnetic waves in any direction and also receive them from any direction. The noise is most often in the form of air reflections.

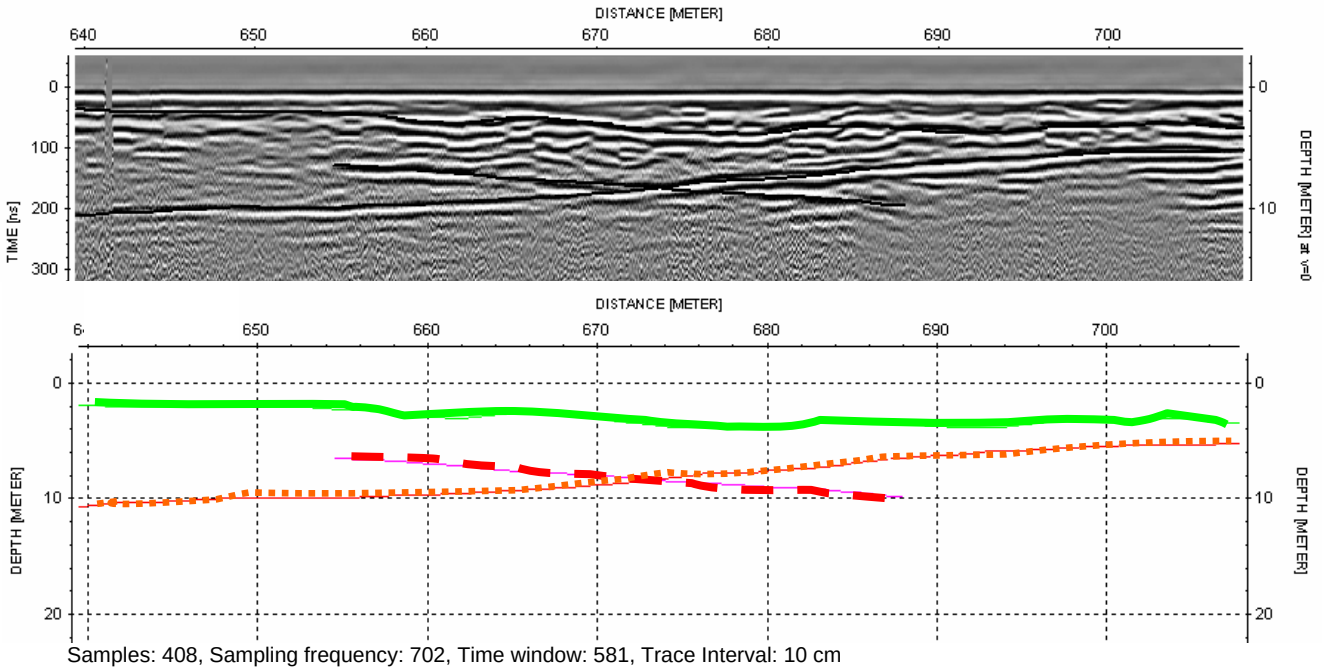
Results

The following results have all been measured with the RAMAC RTC, showing applications of different kinds. Below is a measurement from a lake, aiming at mapping the bottom topography, and also to see if there is any sediment present. In the radargrams the bottom topography is most clearly seen, together with singles objects (seen as so called hyperbolas, some of them marked with arrows) and also underlying layers.



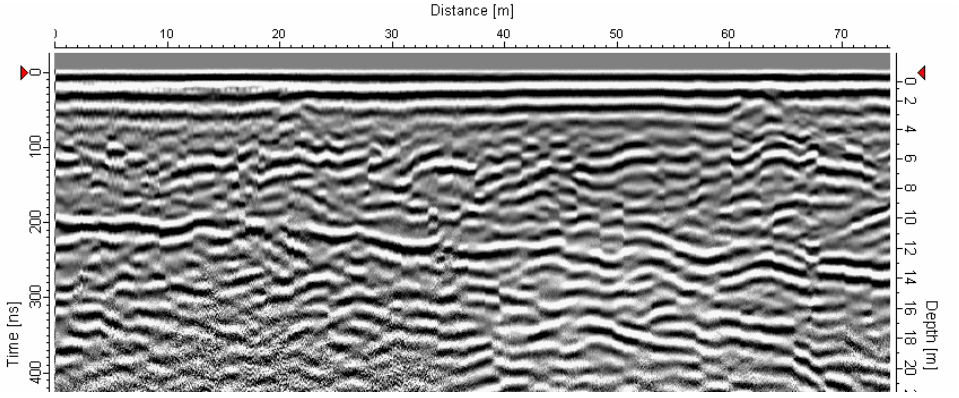
Samples: 1000, Sampling frequency: 508, Time window: 1970, Trace Interval: 0.3 s.

In this example the RTC was used to map a thin soil layer on top of the bedrock (bedrock level marked with green line below), and as a result also larger fracture zone with in the bedrock could also be mapped, represented by the two red lines below.

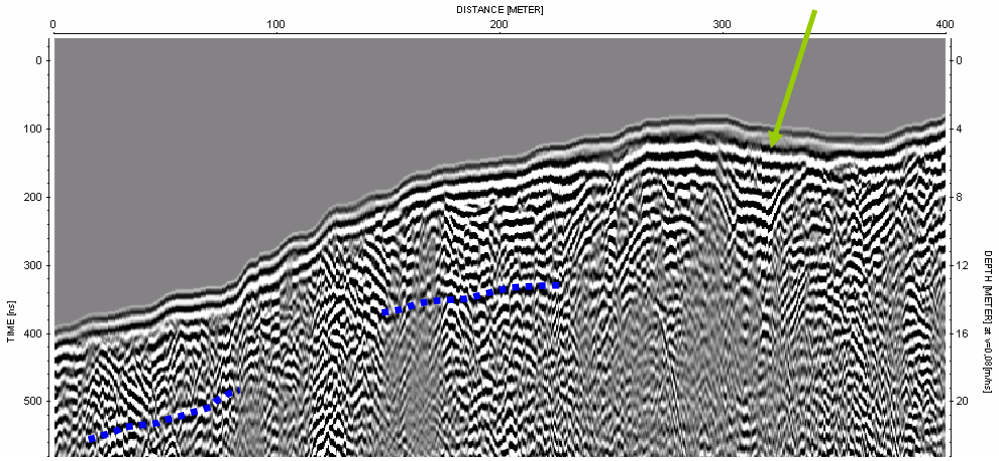


Samples: 408, Sampling frequency: 702, Time window: 581, Trace Interval: 10 cm

The RTC is quite suitable to map groundwater levels in non-conductive areas. The example below is from a sandy area, where the groundwater is clearly seen as a slowly dipping surface at approximately 14 m depth.



The last example is a geological mapping of an esker area, where the structure of the ground is quite nicely illustrated by the RTC. See for example the depression marked with an arrow. However, in these areas, with an extensive amount of boulders, the different layer can be hard to distinguish, due to the fact that the hyperbola pattern complicates the picture. Groundwater level is in some parts indicated, while the bedrock surface cannot be seen.



Samples: 320, Sampling frequency: 570, Time window: 560, Trace Interval: 15 cm

Conclusions

The RAMAC RTC have showed to be a useful low frequency GPR system for a number of different purposes; geological mapping on ground and lakes, structure mapping of bedrock, groundwater investigations etc.

The system is sufficient in performance of mapping stratigraphy and superior in terms if efficiency in fieldwork, especially in non-cleared forest areas, compared to traditional broadside systems. More over, the RT Antenna is always on ground, which gives a very good coupling of the EM energy into the ground.

In terms of fieldwork efficiency, it can be stated that the RTC in forest can be managed in walking speed or slow walking speed, and on track, in walking speed or vehicle mounted.

The RTC is also simple to freight, as all parts can be stored in an ordinary suitcase and the weight is less than 14 kg.

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