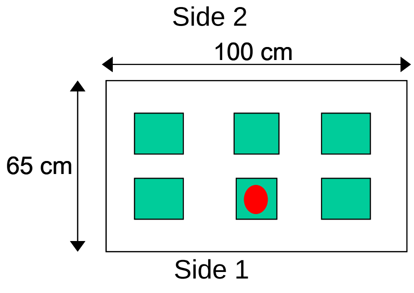
# Investigation of the internal structure of a brick chimney

## Description of problem

To show how air filled holes of cavities within buildings or other structures can appear on a GPR scan, investigations were made on different sides of a brick chimney to see if it was possible to detect its internal pipes, used for ventilation or smoke.

The chimney is constructed of bricks and contains six different pipes at the top of the chimney. Not all these pipes are however going from bottom to top of the chimney. Instead they start at different levels within the building. A simple sketch of the chimney top is given at right. The red mark shows the location of an aluminium pipe within one of the chimney pipes.




## Equipment used

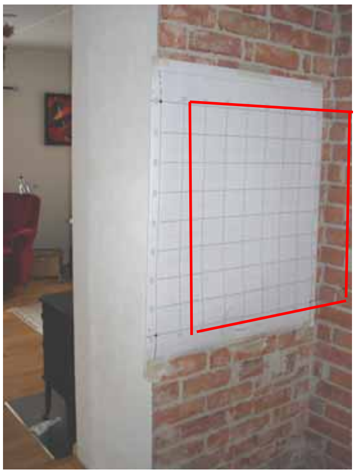
The measurements made in this application note were all carried out with Malå GeoScience CX system with the 1.6 GHz antenna.

The results of the measurements were analyzed within the CX Main unit software and JPEG-images were saved for presentation of the results as several timeslices from the different investigated spots of the chimney. Velocity analyzes, in terms of hyperbola fitting, were carried out in RadExplorer.

## Investigation method

The chimney was investigated from two sides at the 1st floor and at one side on the 2nd floor. The measurements were made as so-called GridProjects within the CX system. This investigation method was chosen to enable a 3D picture (with time-slice function) to see if the different levels of pipes could be identified. The size of the grid was adjusted to fit the different sides of the chimney.

The picture at left below is referred to as side 1, while the other side of the chimney (with the corresponding position of the measuring area marked with red) is referred to as side 2. As seen, a stove is installed at this side, which gives one indication of a pipe location. The red areas show the position of the made Grid measurements.



Side 1

Side 2

## Measurement settings

No special settings were used during the measurements, but standard ones given by the CX Main unit. The sampling frequency of the 1.6 GHz antenna was set to 20 000, 12.5 times the antenna frequency, and the trace distance used was 0.5 or 1 cm. The GridProjects were measured either with 10 or 5 cm distance between the profiles.

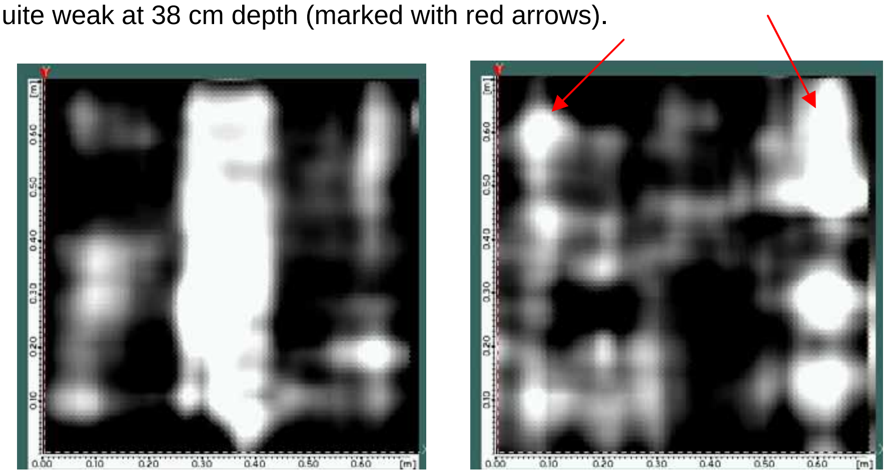
## Critical elements

As the bricks are made of clay and no information was available if the pipes were internally covered with for instance metal, it was hard to know the depth penetration of the brick construction. However a single test profile showed hyperbolas at different levels to a depth of approximately 40 cm, and when the chimney is being 65 cm wide this was considered quite good.

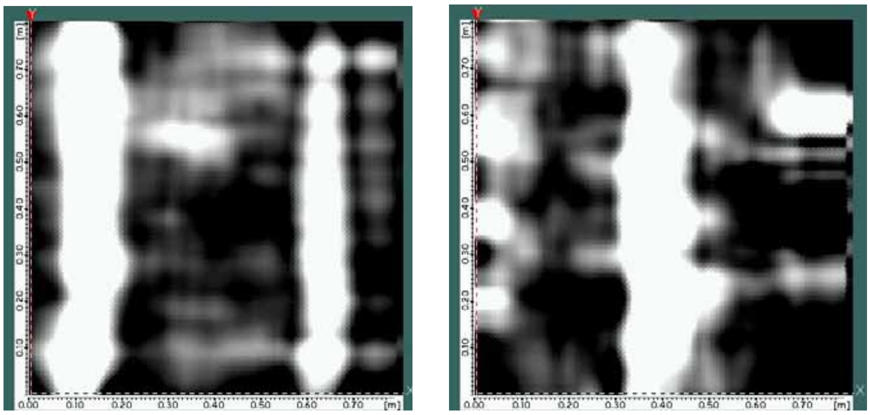
To get the correct velocity of the material, the single radargrams measured were used to analyze the velocity, with help of clear hyperbolas. In this case the analysis resulted in a velocity of 100 m/ns.

## Results

The two GridProjects made on the 1st floor clearly show the location of the chimney´s internal pipes closest to the measured side. Indications of the second pipe layer is also seen from both sides. At side 1 the indications are quite weak at 38 cm depth (marked with red arrows).



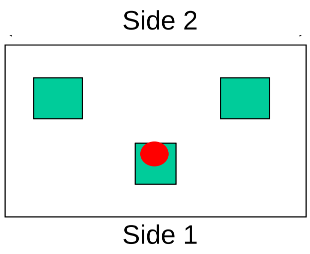
**Side 1** 14 cm depth 38 cm depth



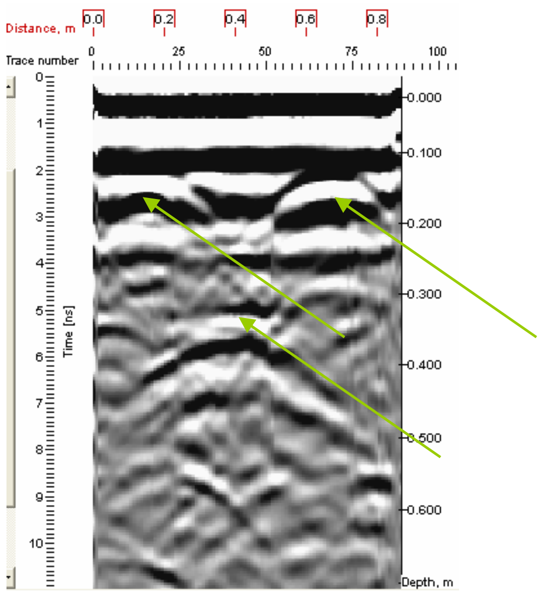
**Side 2** 17 cm depth 39 cm depth

At side 2 the reflections of the pipe closest to side 1 is as strong as measured from side 1 indicating a difference in material. This pipe, as seen above, contains the aluminimum pipe with a diamter of approximately 5 cm.

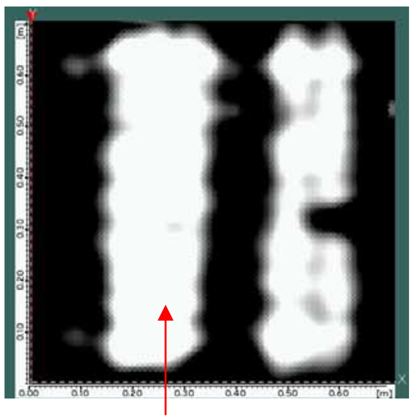
From the two Grid measuremts from side 1 and 2 on the 1st floor it can be concluded that the pipes are located as follows:

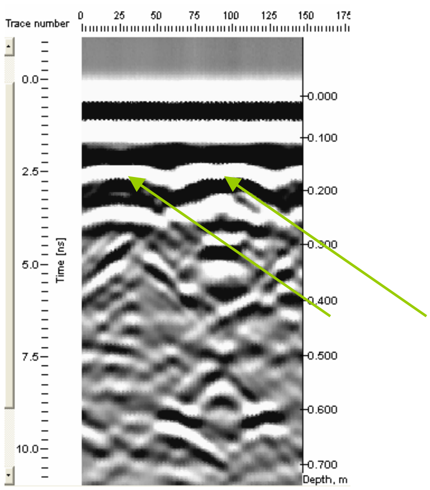



The radargram below is measured on side 2 from 0 to 80 cm (left to right). Also here the three identified pipes in the GridProject results above are seen very clearly, as quite wide hyperbolas, marked in the radargram with arrows.




On the 2nd floor only one side of the chimney was free to measure, this side corresponds to side 1 on the 1st floor.

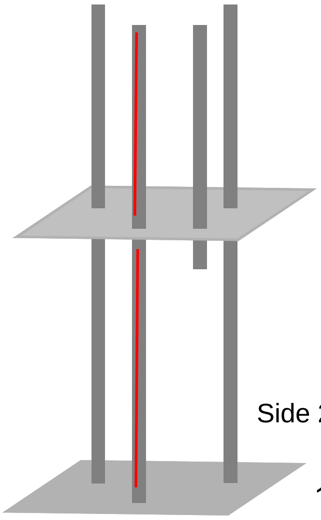





2nd floor 16 cm depth

Radargram measured from right to left

Here two pipes were clearly identified at a depth of approximately 16 cm. One of these corresponds to the pipe from the first floor (the left one is on the same location as the pipe with the internal aluminum pipe, marked with an arrow) but also another is seen, a ventilation pipe starting between the two floors. Again the pipe containing the aluminum gives a bit stronger back-reflection. The two pipes are also seen in the single measured radargram as clear hyperbolas, marked with arrows in the picture above. However, the second layer is harder to identify, most probably due to the fact that the two pipe layers are situated on top of each other, giving reflections interacting. Unfortunately the GridProject could not be started at the edge of the chimney, so that's why the pipe from the stove is not seen at all.




A simple drawing of the pipe location at 1st and 2nd floor is given at left. As seen the pipes on side 2 goes trough both floors, while one of the pipe on side 1 only goes through the second floor. The chimney contains 6 pipes in total, so the two missing pipes in the picture at left are only going from top of the 2nd floor and up.

The pipe (on side 1) containing the aluminum pipe is marked with red.

## Conclusions

The measurements to detect air-filled holes within brick structures were successful; the pipes were clearly seen in the GridProjects. The CX system provides a very fast and easy tool, where results can be produced directly on the investigation site.

The results of this investigation give an indication that voids within brick or concrete structures should be detectable. A typical application could be in concrete constructions were the aim is to map the location of ventilation shaft or ducts containing electrical installations. Other applications could be archaeological, where voids  in masonry structures are to be found.

**Head Office**

MALÅ GeoScience AB
Skolgatan 11, SE-930 70 Malå, Sweden
Phone: +46 953 345 50  Fax: +46 953 34567
E-mail: sales@malags.com

**Sales Offices**

USA: MALÅ Geoscience USA, Inc., 2040 Savage Rd. Box 80430, Charleston, SC 29416
Phone: +1 843 852 5021, Fax: +1 843 769 7397, E-mail: sales.usa@malags.com

Malaysia: MALÅ GeoScience (Asia Pacific), 9G-B, Jalan Prima 9, Metro Prima, Kepong, 52100 Kuala Lumpur
Phone: +60 3 6250 7351, Fax: +60 3 6250 2072, E-mail: sales@malags.com