



National Institute of R & D for Optoelectronics

# Ground Penetrating Radar Survey Inside the Church Saints Princes from Baia de Aramă

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# Investigated Area Presentation

## Church Saints Princes from Baia de Aramă, Mehedinți County, Romania

- Construction start in 1699, under Saint Constantin Brâncoveanu ruler's order
- The building was used as a monastery of monks, a parish church and now, since 2008, as a convent
- Religious monument due to its brancovenesc construction style and to its 300 year old murals.



## Cause

- It is believed that Brancoveanu hid all his treasure under one of the churches he built.
- In 1996, in the Saints Princes' altar in a tin box, it would be found some documents from 1703 holding Brâncoveanu's seal and signature attesting that the treasure was hidden under this church.
- Hundreds of people storm into the area in 1997 trying to find the buried gold, after the news was made public. The church was broken into multiple times and people have illegally dug it. Shortly after this, the altar was cemented to discourage this kind of acts.
- At the end of 2013 some archeologists have tried to continue the searches by excavating around the place of worship up to 3 meters, hoping underneath the church and ruining the construction's foundation, leading to the shipyard closure.

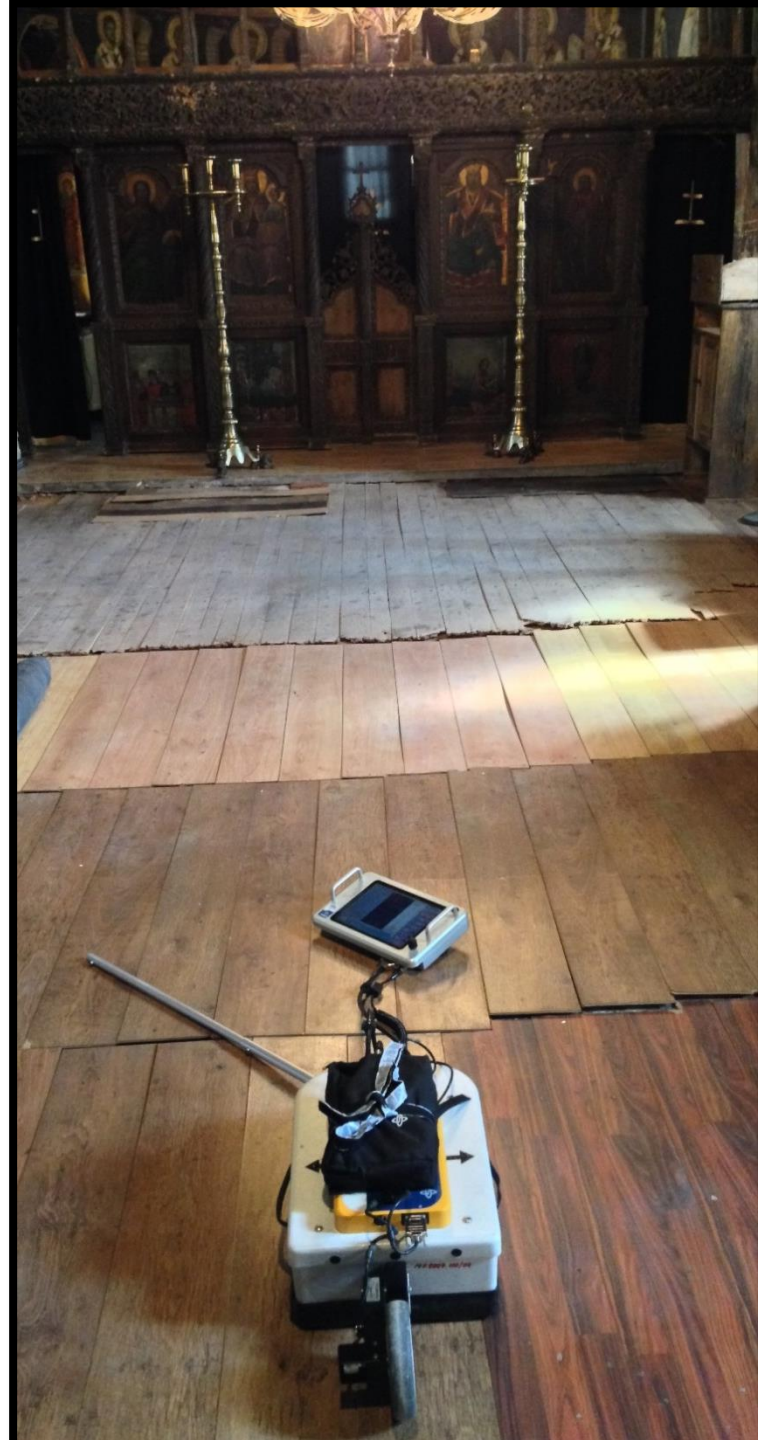
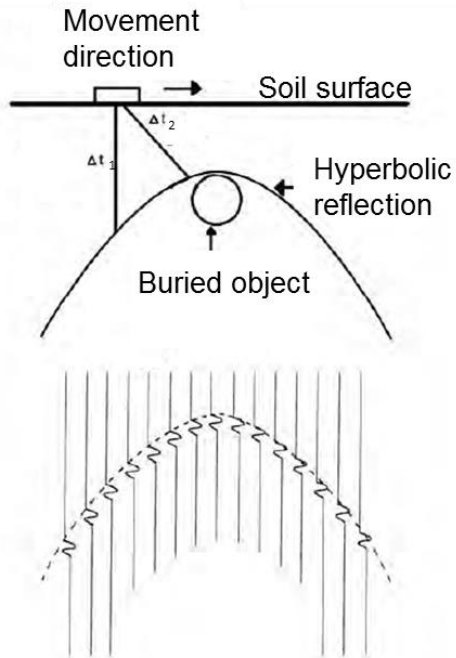


## Short GPR Presentation

In 2015, non-invasive investigations were conducted using a geo-physical method with the purpose of identifying the position of the supposed buried treasure.

The ground penetration radar (GPR) is a non-invasive geophysical method of investigating the ground by emitting and studying the propagation of electromagnetic pulses.

The radiation used is from the microwave spectrum (UHF / VHF) which is reflected due to the discontinuity of dielectric materials.



## GPR Advantages and Limitations

### Advantages

Non-invasive

Indication of position of the buried remains with a high precision

High efficiency in discovering objects regardless of the physical and chemical characteristics of the constituent material

Fast data acquisition

High horizontal and vertical resolutions (of centimeters)

Estimation of the buried objects' size

### Limitations

Clay soil

Water presence in to the soil

Metal, shields the electromagnetic waves propagation

# Investigation

Records taken in all four convention halls of the church: - porch  
- narthex  
- nave  
- altar

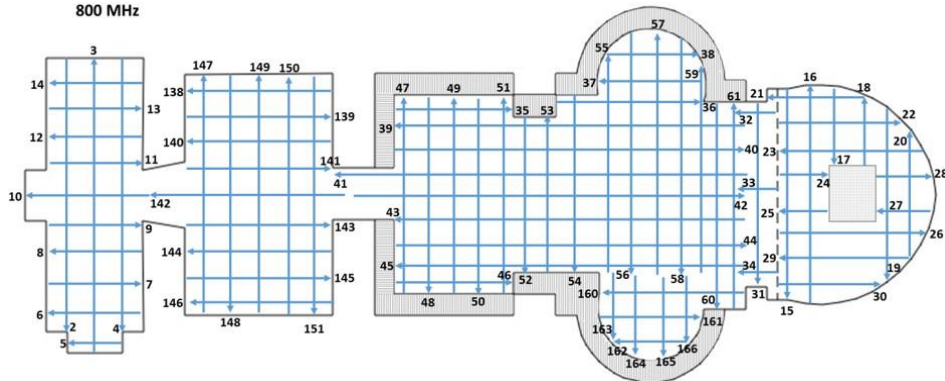
Two antennas were used, with center frequency of: - 500 MHz  
- 800 MHz

Exploration depth up to 8 meters.

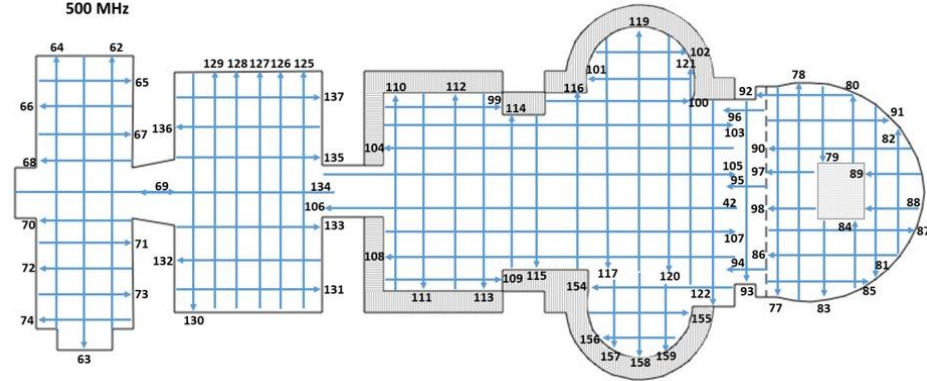


The acquisition system respected a perpendicular grid with a spatial resolution of 0.7 meters, as presented in the sketches below.

800 MHz

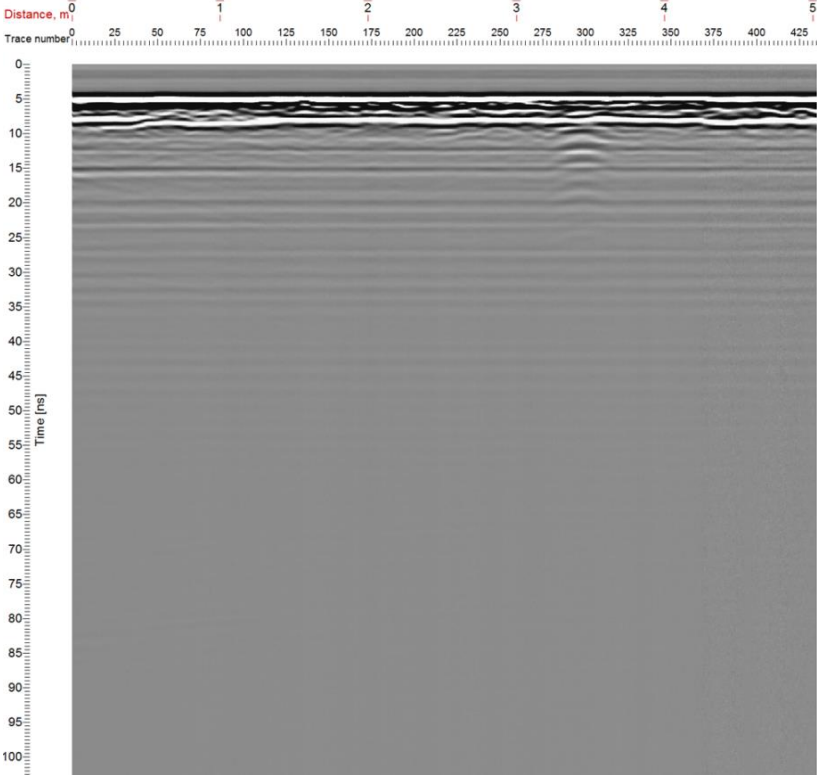


500 MHz

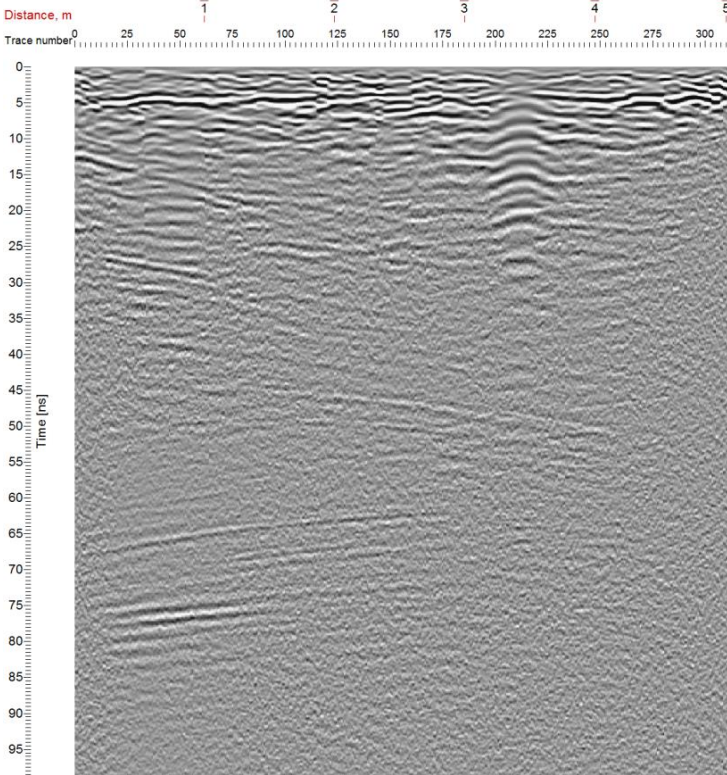


# Filters and Algorithms

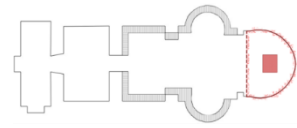
### Raw data



### Process data

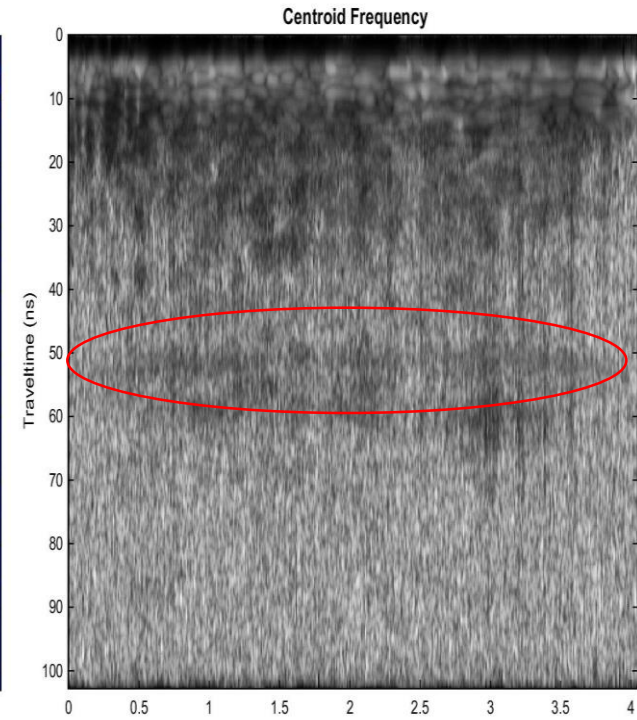
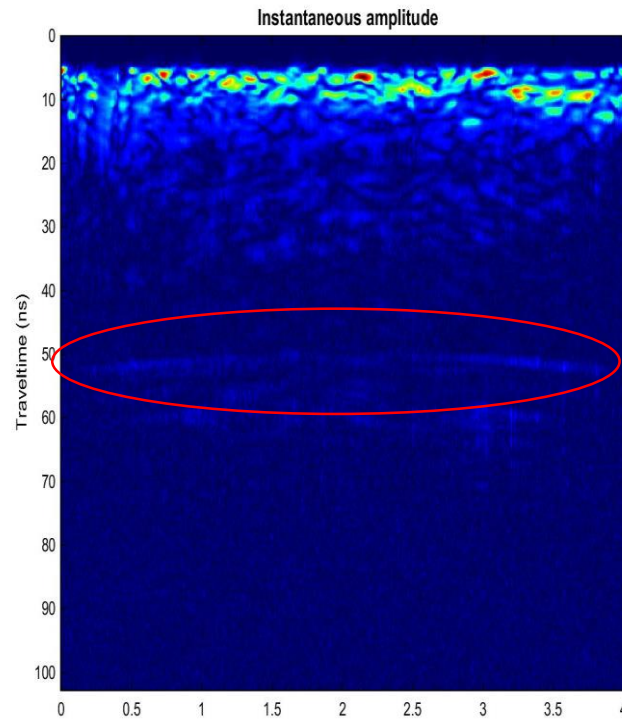
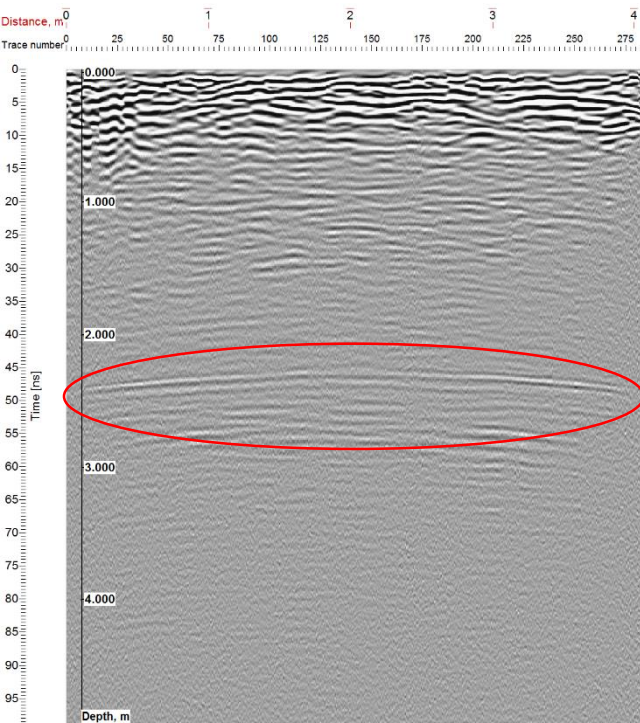


# Results

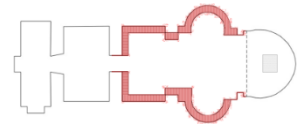


Only three areas presented electromagnetic wave modifications which would raise interest. The areas were the altar, the nave and the porch.

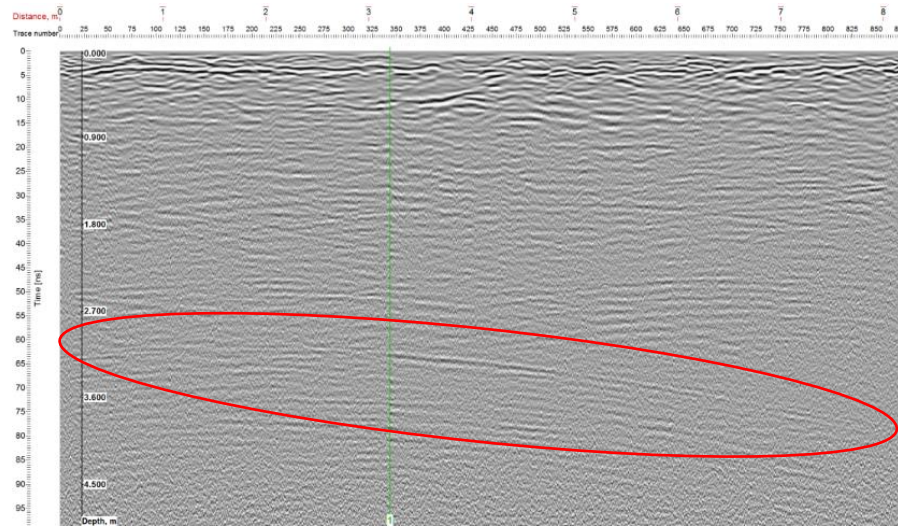
- Altar, 800 MHz antenna (16):** – stratigraphy difference at depth of approximate 2.7 meters
- heterogeneous layer up to 0.8 meters, this representing the cement poured



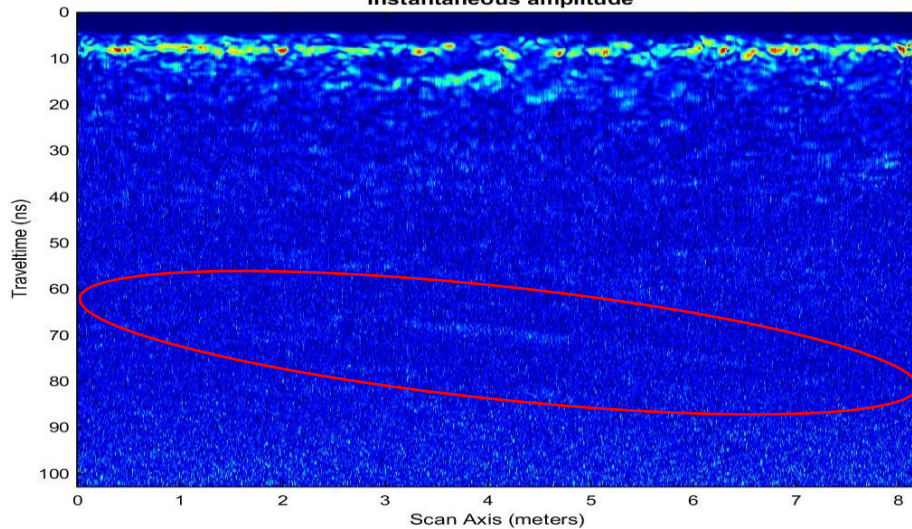




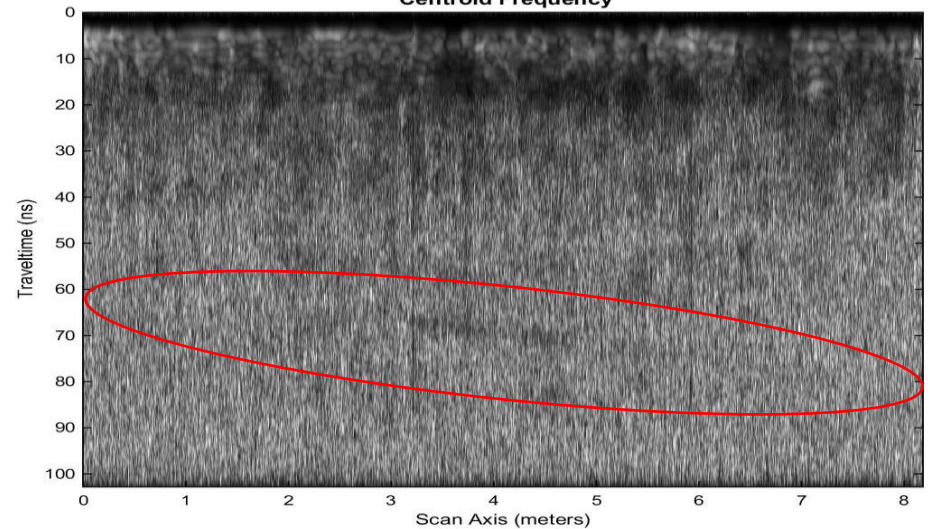
**Nave, 800 MHz antenna (43):** – stratigraphy difference, reflections caused by the rock layer, starting from the depth of 3 meters towards the altar and up to 4 meters to the porch.



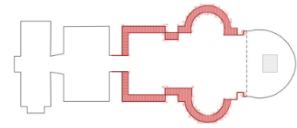
Instantaneous amplitude



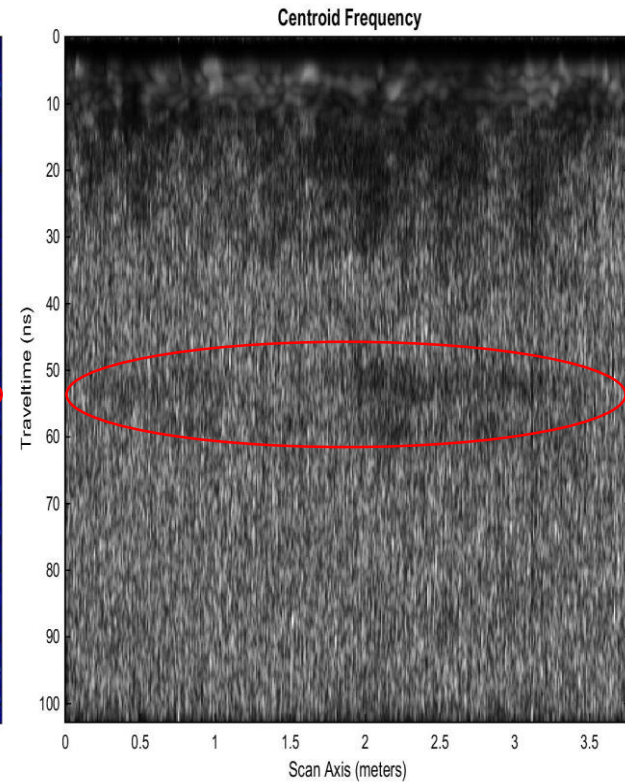
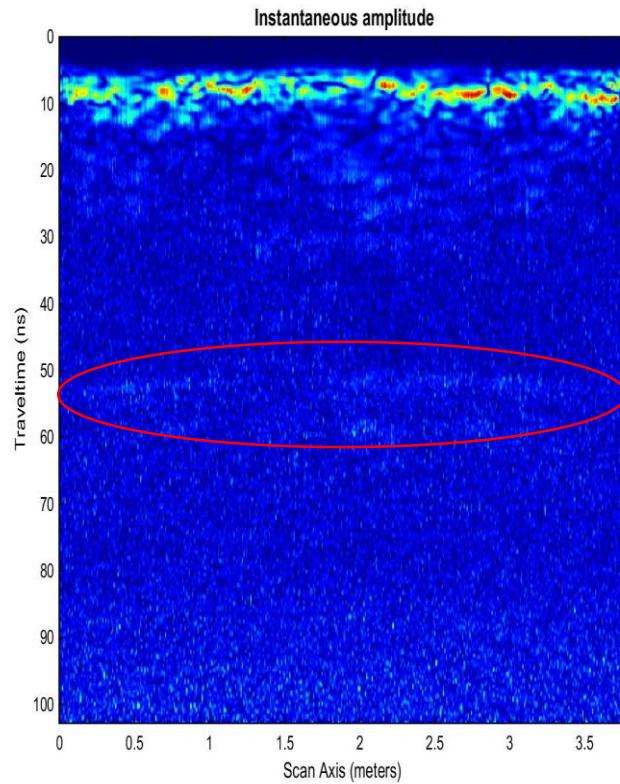
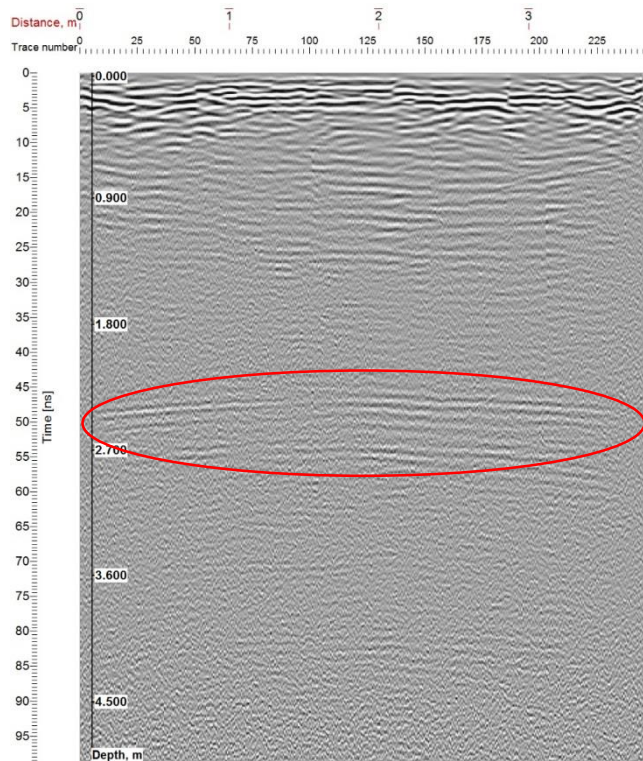
Centroid Frequency



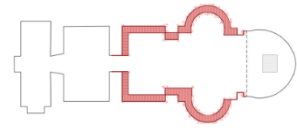
# Results



## Nave, 800 MHz antenna (50): – stratigraphy difference

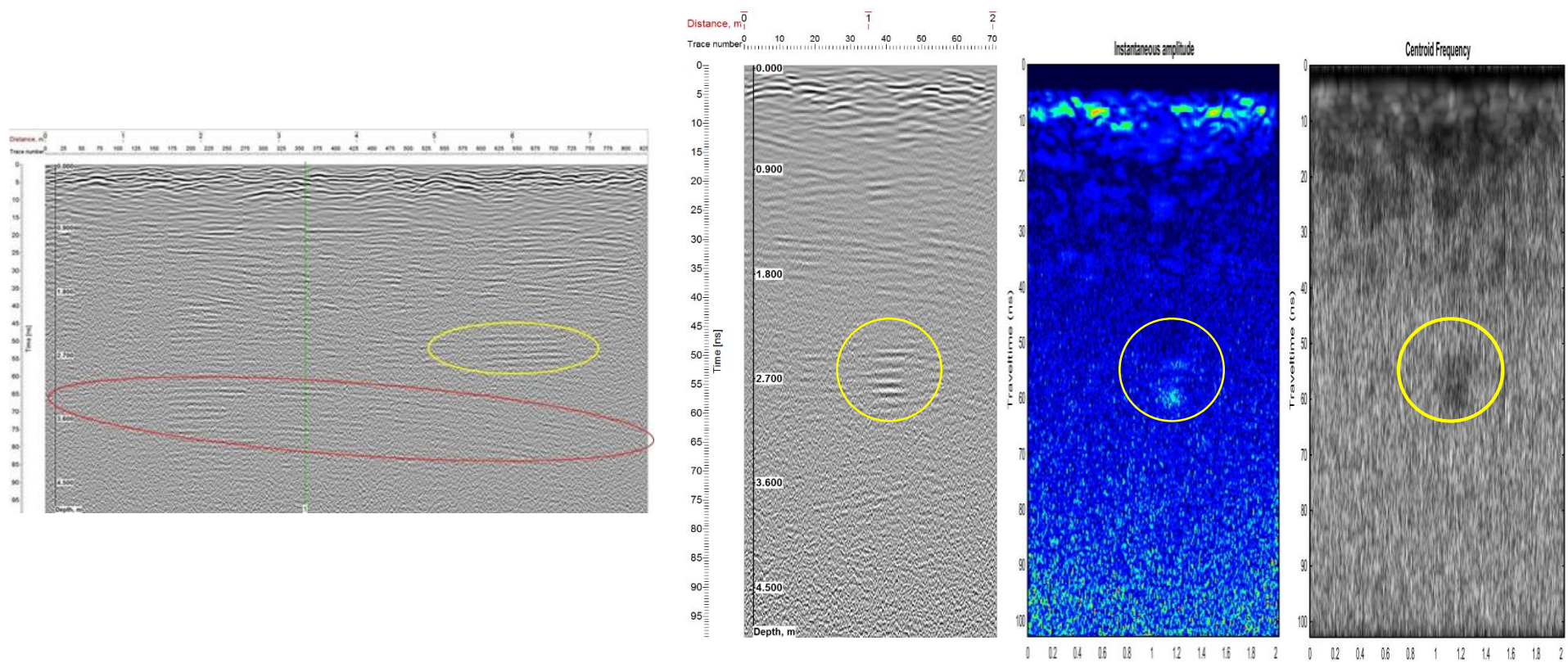


# Results

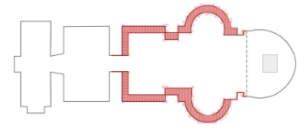


**South Western nave's area, 800 MHz antenna (46):** – minor modification in the electric conductivity parameters

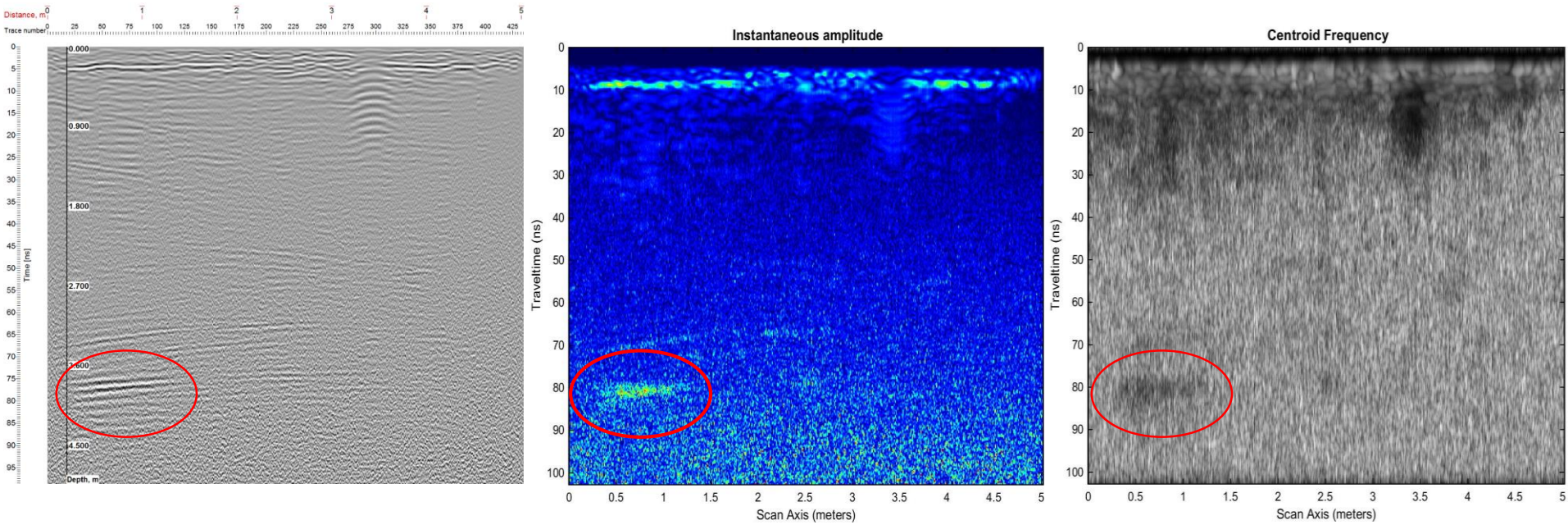
Considering the depth and the dimensions of the reflections, the area may represent human remains or foundation elements.



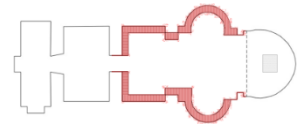
# Results



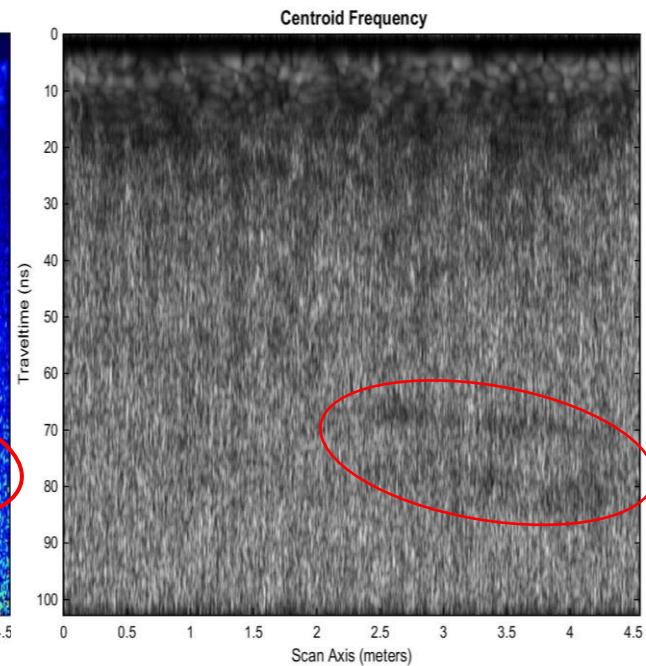
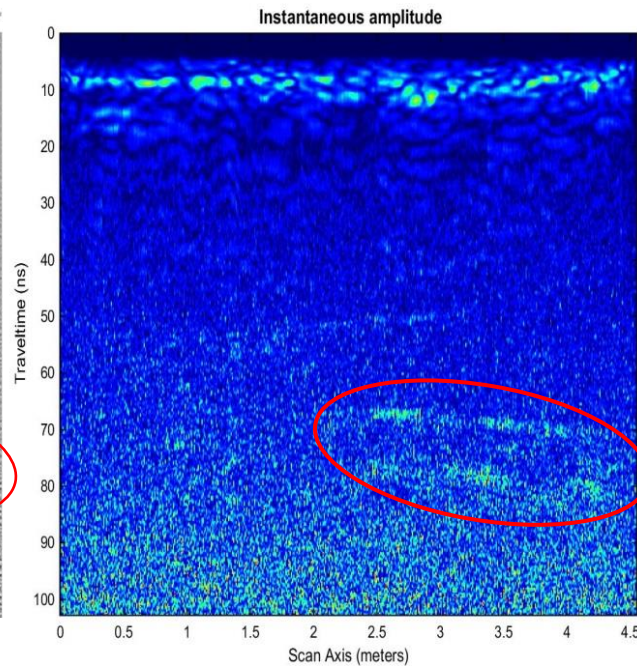
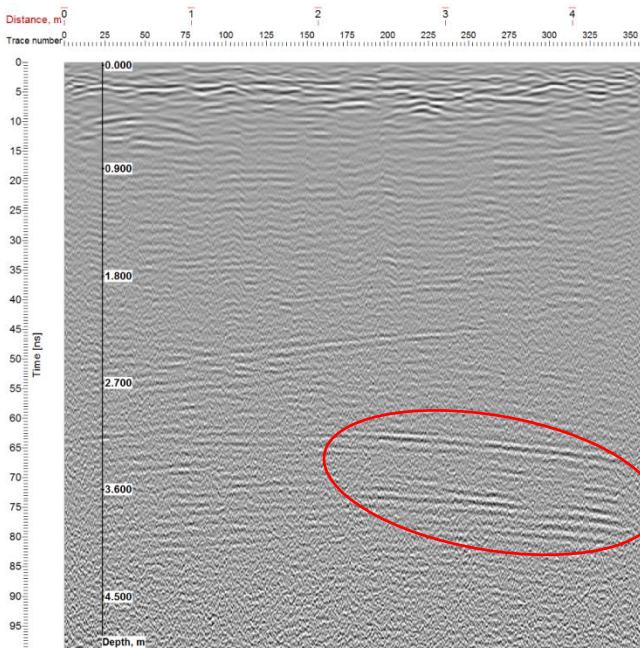
**Northern nave's area, 800 MHz antenna (56):** existence of an excavation, characterized by a different local soil slump, with a strong response indicating the presence of a metal.



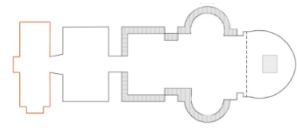
# Results



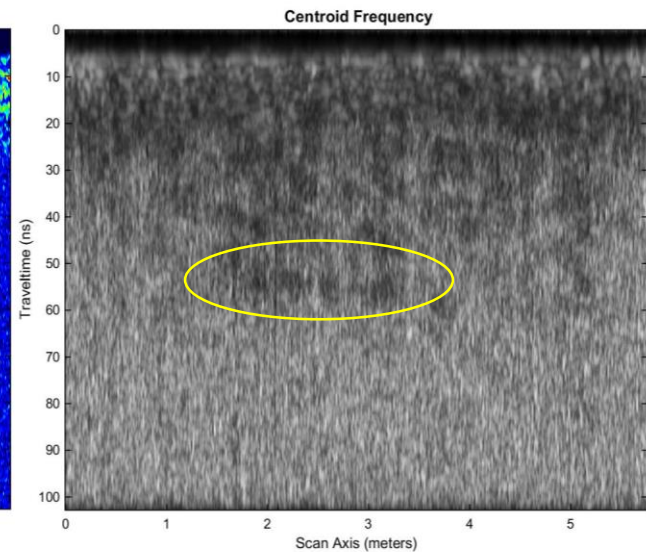
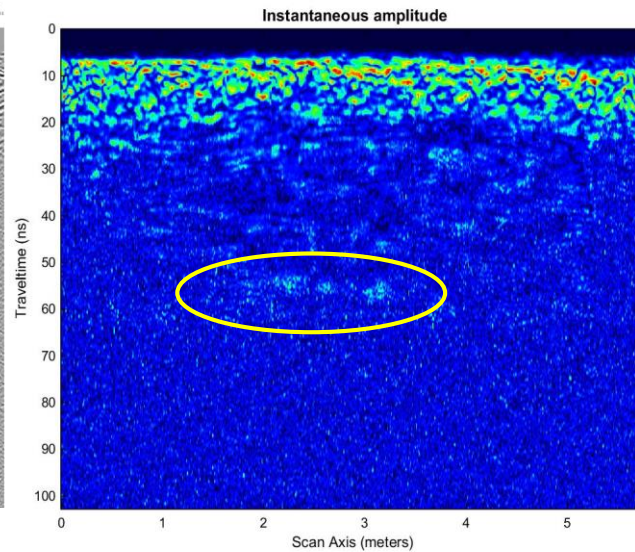
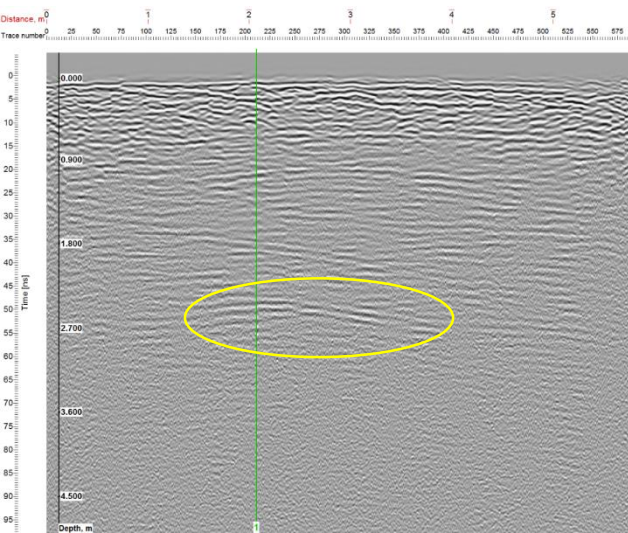
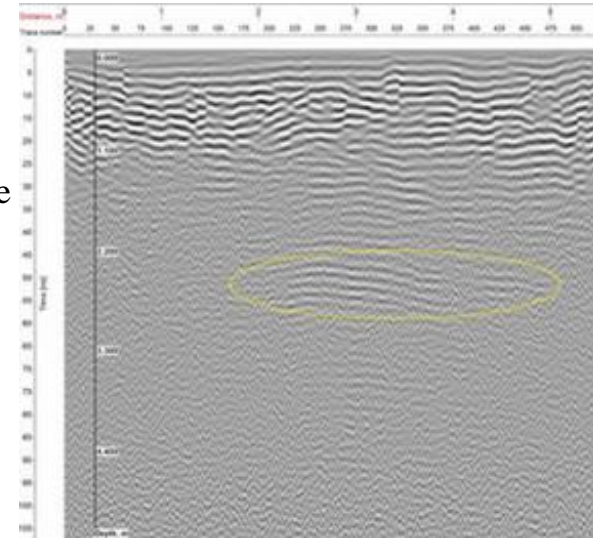
**Northern nave's area, 800 MHz antenna (55):** Correlating these results with the probing conducted in the same area in 2013 and the blocking of the drilling element into the soil, we can assert that there's a high probability that this is the metal detected.



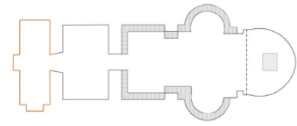
# Results



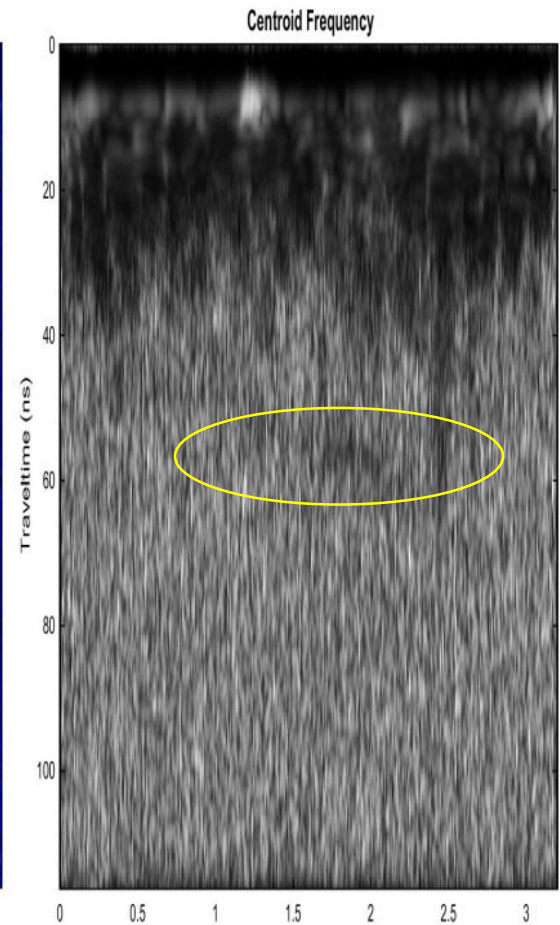
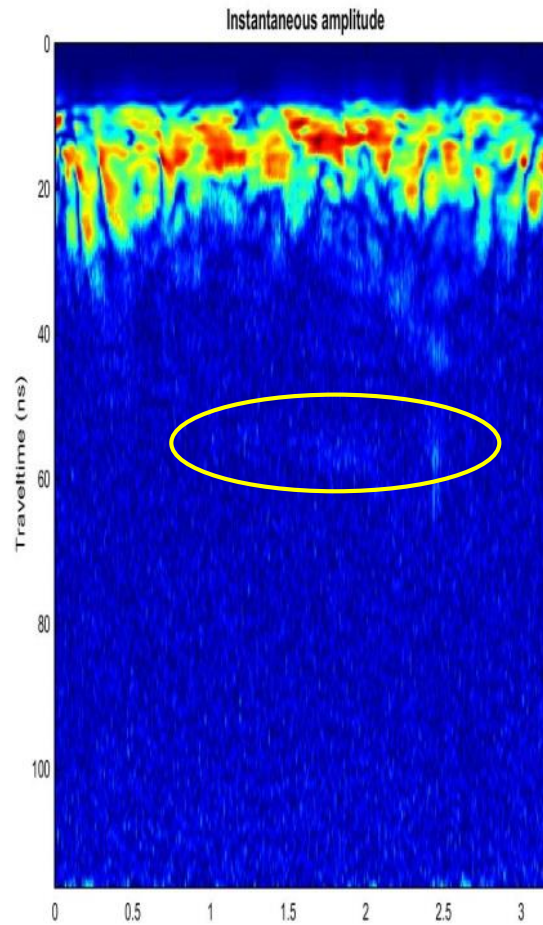
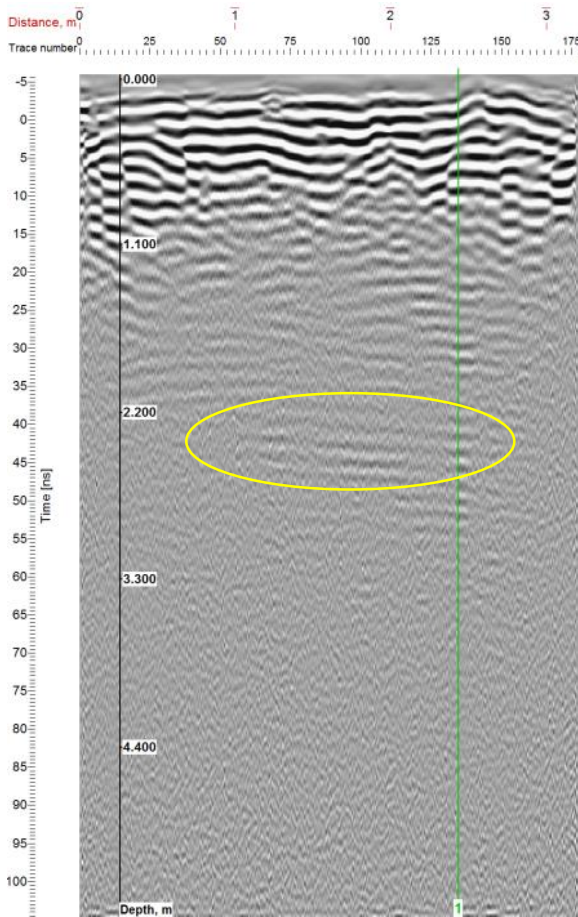
- Northern porch's area, 800 MHz antenna:**
- same response obtained in S-W nave part
  - depth of approximately 2.5 meters
  - modification of the radiation's propagation which may mark the existence of a grave



# Results



- Northern porch's area, 500 MHz antenna:** - the reflections are noticeable around the depth of 2.5 meters, as in the case of the scans created with the 800 MHz antenna
- we can approximate the dimension of the presumed buried object, the grave, to have 2 meters length and 1 meter width



## Conclusions and Future Work Plan

- At a depth between 2.7 and 4 meters, a strong, homogeneous response was obtained in almost all of the 170 records. The presence of this layer indicates a change in the soil's component, most probably indicating the rock on which the church is built.
- In the nave's Northern part, at a depth of approximately 4 meters, a response indicating a large volume of temporary dislocated ground was received, alongside a strong response that may indicate the presence of a metallic object of small dimensions.
- The second interesting area from the nave is represented by the South Western corner, with a 1.5 meter footprint at a depth of approximately 2.7 meters.
- Another interest area was detected on the porch at a depth of 2.5 meters in its Northern part. The parameters detected in this area are similar to the ones in the nave. Human remains or foundation elements may be present in both zones.

