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# Testing the use of GPR to detect clandestine graves in a San Diego soil

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## Abstract

The purpose of the experiment is to consider the usefulness of GPR in forensic investigations of clandestine graves in the San Diego region. Ground Penetrating Radar (GPR) is a common tool used to view objects within the subsurface. The penetration and resolution of a GPR unit can vary with frequency used and soil type. A 6.58 kg turkey and 4.54 kg ham were buried at depths to bottom of .75 meters and 1.25 meters respectively. There is also a 1m diameter aqueduct pipe that traverses the site at approximately two meters deep. The soil type at location of survey was a poorly graded clayey silty sand common of the San Diego area. The 100MHz antenna revealed no significant data. The 500MHz antenna revealed the shallower ham and the aqueduct. The turkey was not obvious, but may become more apparent with further filtering.

## Objective and Hypothesis

-To test the capabilities of Ground Penetrating Radars for forensic use in a common San Diego area soil

- Does experimental resolution match theoretical resolution?

Resolution varies with depth, soil type, materials and shape of objects in the subsurface. A ham, turkey and aqueduct are located in the soil at depths of .75 meters, 1.25 meters and 2 meters respectively. The items vary in size and shape.

## Procedure

- Knowing the depth and dimensions of the aqueduct, it was surveyed first.

- Then the ham and turkey were buried and surveyed on a grid (Images 1-6 and figure 4-6).

- Data was imported into Matlab and filtered (demeaned) and images created for analysis (Figure 1 and 2).

- Using the known depth of the aqueduct, radar propagation velocity was determined and resolution calculated.

## Calculations

- Theoretical resolution is approximately 0.5 wavelength ( $\lambda$ ) 3 cm. This should provide us with the necessary resolution to reveal the buried items.

- Using  $c = (c / v)^2$ , the dielectric constant is equivalent to 53. A dielectric constant of this means the soil is significantly saturated.

- Dielectric constants of various materials  
Air= 1 Sea Water= 80 Granite= 5 Saturated Sand=25

Sampling Rate (Nanoseconds/sample)	# of Samples	Total Distance Traveled (meters)	Two-way Travel Time (Nanoseconds)	Velocity (meters/second)	Wavelength $\lambda = v/f$ (meters)	Resolution for equidimensional objects $\approx 1/3 \lambda$ (centimeters)
9.77E-02	100	4	9.77E-08	4.10E+07	8.19E-02	2.73

Calculations performed on excel to determine velocity and wavelength

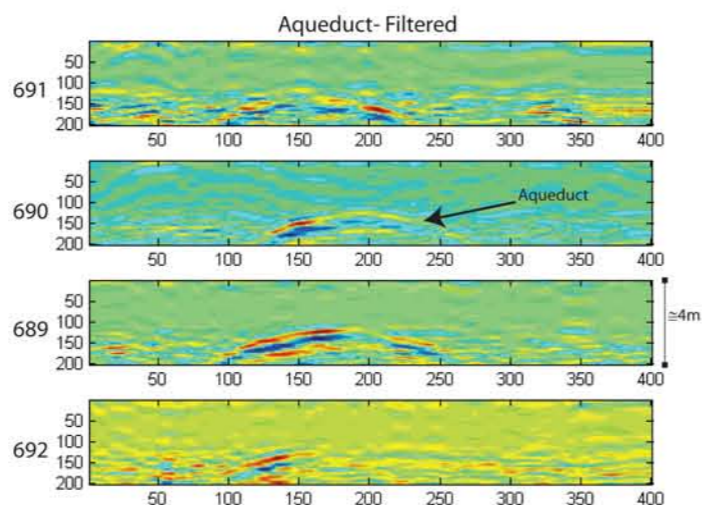


Figure 1: Shown above is an aqueduct buried at an approximate depth of 2 meters. The results are filtered to remove "ringing" and background noise. With that scale 1 meter is equivalent to 50 units on the vertical scale. The horizontal axis does varies in distance because the speed of subject operating the equipment can vary.

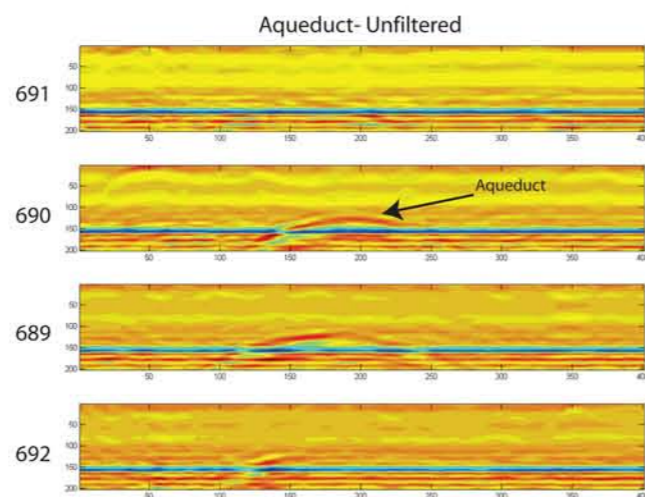


Figure 2: Shown above is an aqueduct buried at an approximate depth of 2 meters. The results are not filtered showing "ringing" and background noise. With that scale 1 meter is equivalent to 50 units on the vertical scale. The horizontal axis does varies in distance because the speed of subject operating the equipment can vary.

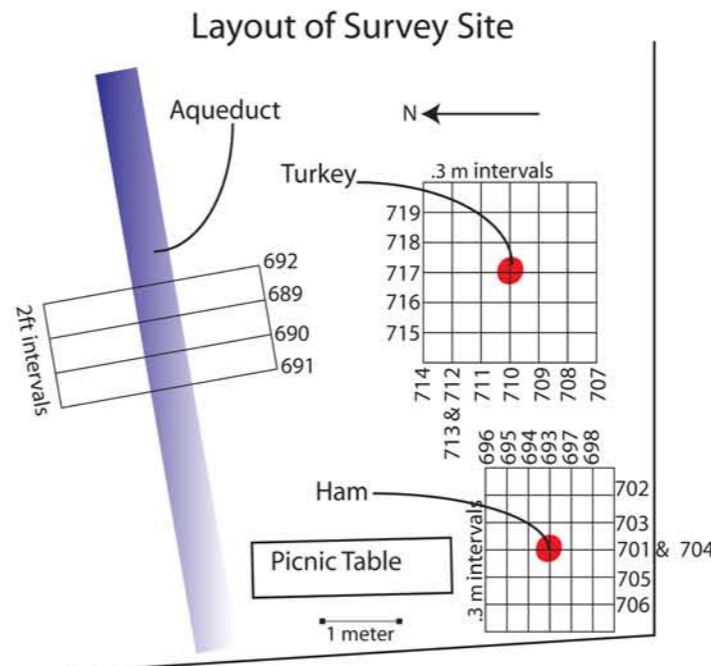


Figure 3: Shows layout of survey site and paths of traverses. The scale is an approximation.

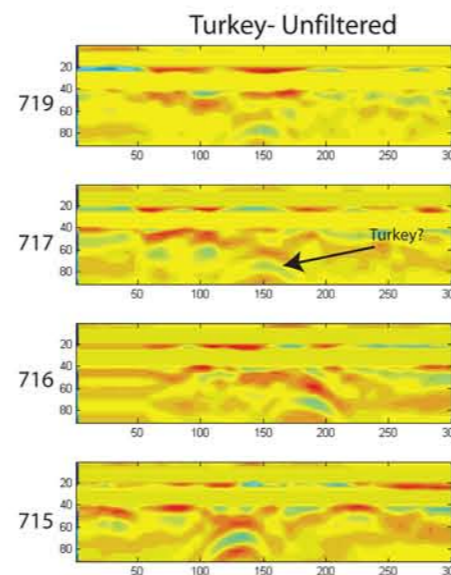


Figure 4: This image shows the results of the turkey with the North South traverse. The results are unfiltered because the filtered results provided no additional data. Also there was no evidence of the turkey with the East-West traverse and that is why it is not pictured. Horizontal scale is not applicable and vertical scale is approximately 1 meter per 50 units.

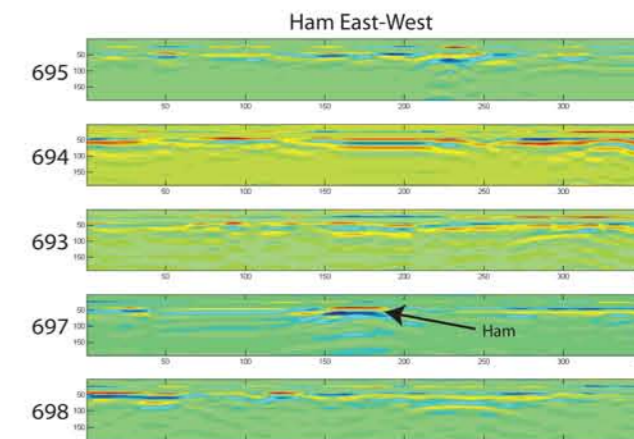


Figure 5: This shows ham in the East-West traverse with results demeaned. Possible image of ham in image number 697.

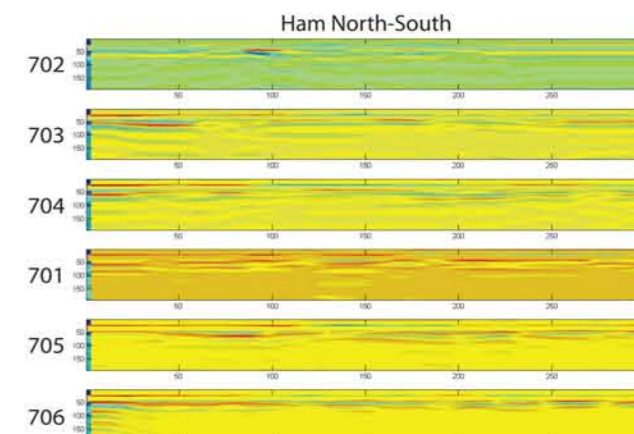


Figure 6: This shows North-South traverse of ham with results demeaned. No significant image of the ham, but possible image of disturbed soil in image 701.

## Conclusion

- The 500 MHz GPR can resolve objects as deep as 2 meters in a typical San Diego Soil.
- Both the ham and the turkey were difficult to detect directly.
- The disturbed soil was detectable.
- We determined the velocity within the soil to be  $4.10 \times 10^7$  meters per second.
- Successful detection of small body parts would require a higher frequency GPR unit.
- We suspect the low contrast in dielectric constant between soil and poultry caused a poor signal.

## References

- Miles, M. L., Freeland, R. S., & Koppelman, S. K. (2002). Searching for concealed human remains using GPR imaging of decomposition. In S. K. Koppelman & H. Lee (Eds.), *North International Conference on Ground Penetrating Radar* (Vol. 4758, pp. 539-544). Bellingham, WA: SPIE.
- Schultz, J. J. (2003). Detecting buried remains in Florida using ground-penetrating radar. Unpublished doctoral dissertation, University of Florida, Gainesville.
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Image 1: Shows 100MHz unit ready to survey turkey.



Image 2: Shows turkey ready to be buried.



Image 3: Turkey ready to be buried. Zoomed out to give sense of scale.



Image 4: Turkey at the bottom of hole.



Image 5: A GSSI GPR unit.



Image 6: Shows layout of site including equipment.