

GEOL460: Emory Grove Cemetery

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MAUDE F.
TAYLOR
MAY 23, 1903
JAN. 2, 1997

EDWARD U.
TAYLOR
OCT. 4, 1898
NOV. 7, 1951

Introduction

Problem

- certain graves at Emory Grove Cemetery are unmarked
- knowledge of their locations are needed to:
 - Properly identify lost loved ones
 - Determine whether the cemetery needs to be shut down

Goal

- use a Ground Penetrating Radar System to locate graves in the subsurface
 - 13x14.5m grid with 25cm of spacing

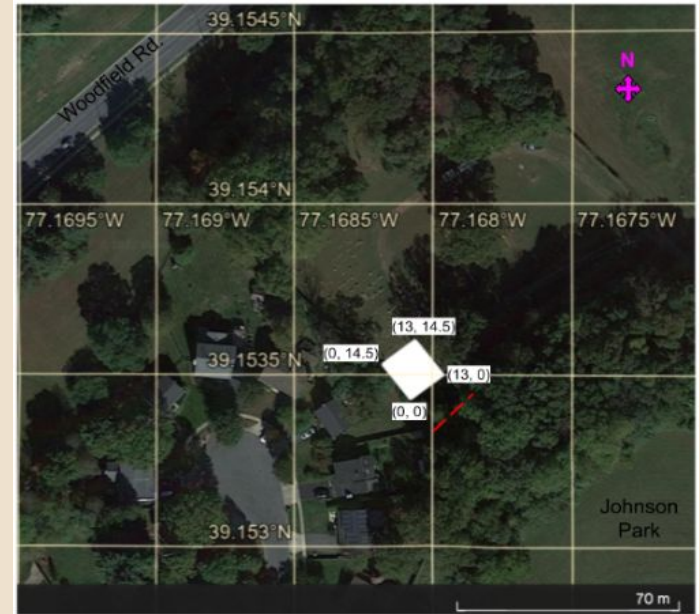


Figure 1. Site map, Google Earth

Introduction

Geological Setting

- topographically flat
- Mather Gorge Formation
 - placed during Lower Cambrian and/or Neoproterozoic Period
 - quartz-mica schist interlayered with quartzitic metagraywacke

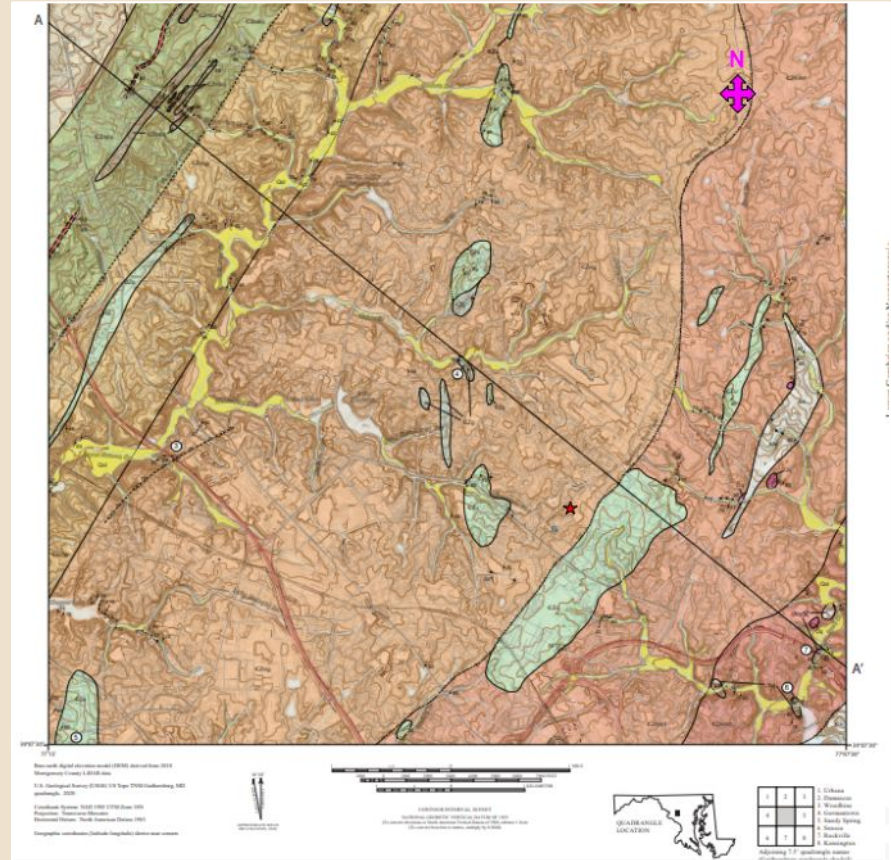


Figure 2a. Geological map of the Gaithersburg Quadrangle from MGS [1]

Introduction

Geological Setting

- Cross section view:

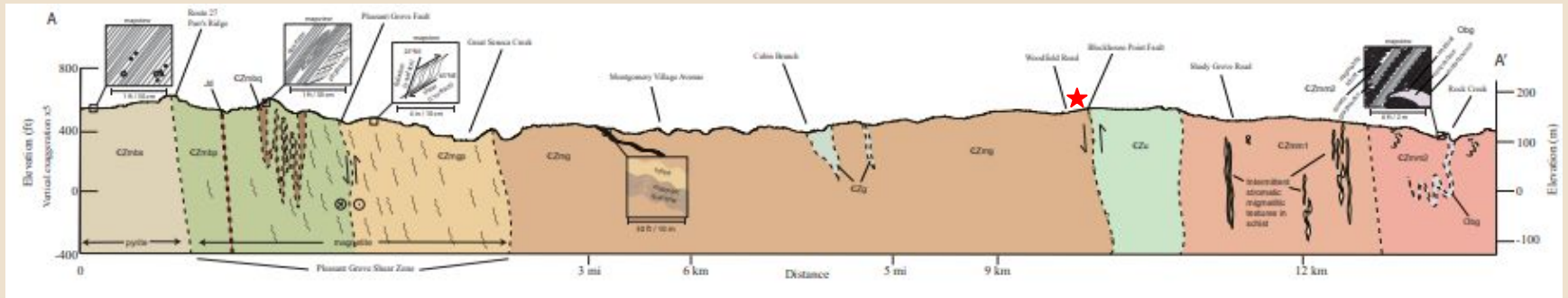


Figure 2b. Geological map of the Gaithersburg Quadrangle cross section from MGS [1]

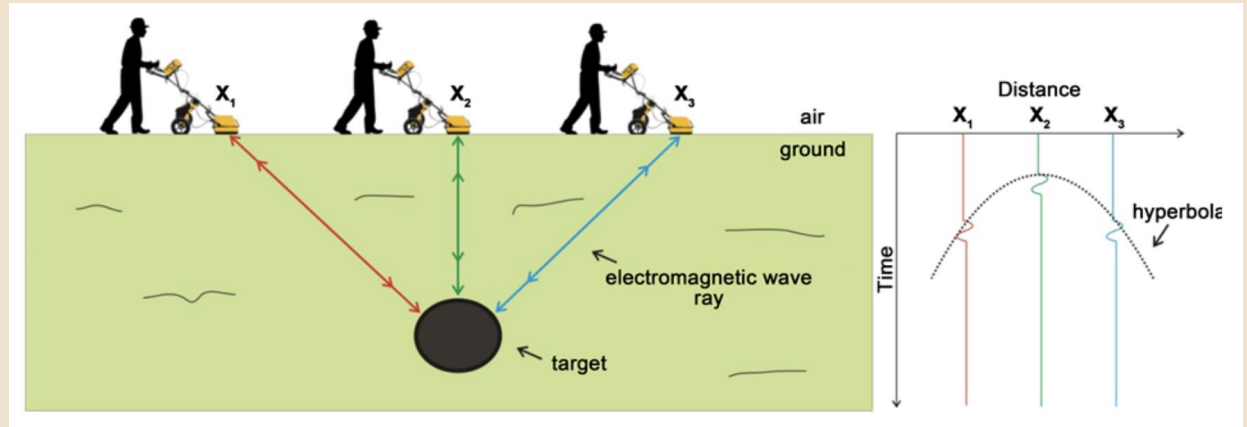
Geophysical Methods

GPR Theory

- relies on high-frequency electromagnetic waves
- detects variations in subsurface dielectric properties

Instrument Mechanism

- transmitter emits pulses; receiver captures reflections
- analysis of reflections reveals subsurface data
- SIR 4000 GPR system operating at a frequency of 400 Hz



Geometry of data collection



Data Processing

1. time zero correction
2. high pass filter: 100 MHz, Low pass filter: 800 MHz
3. linear gain to amplify resolution of the depths of the graves (~1.5 m depth)
4. velocity migration
 - a. deflector: 0.078 m/ns
 - b. radar dielectric constant: 16
 - c. intercept time: 22.13 ns

Noise Sources

- phones
- car radios
- electrical lines
- solar noise
 - 11/11/2023: moderate solar activity (spaceweatherlive.com)

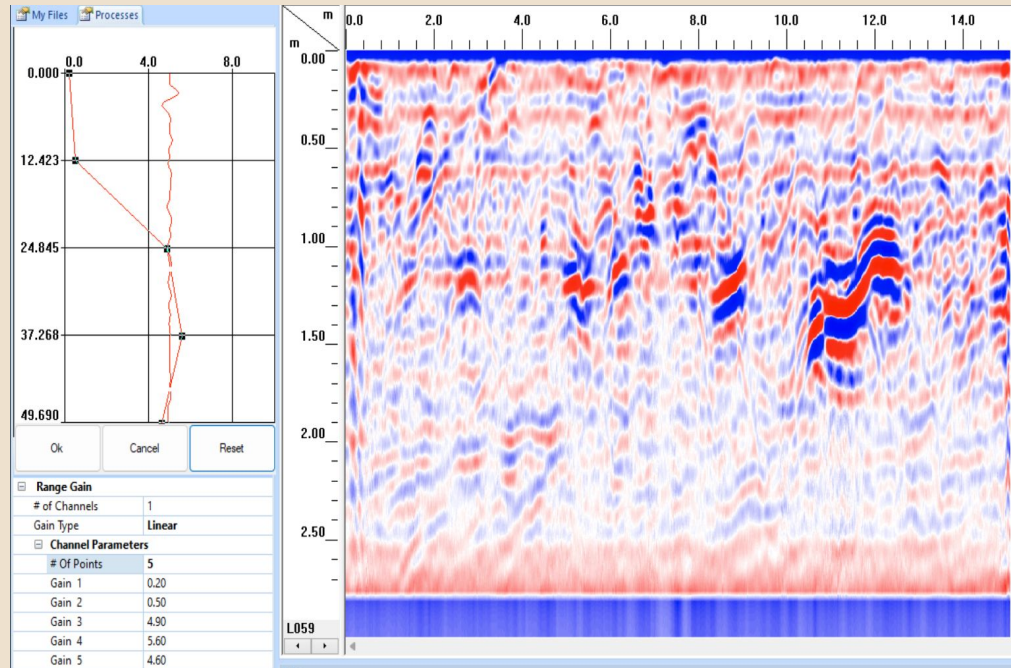


Figure 3. Screenshot from Radan 7 with an applied linear gain to amplify the resolution of graves' depth (~1.5m). The bright red and blue hyperbola from file L059 is the known gravesite located near (0, 14.5).

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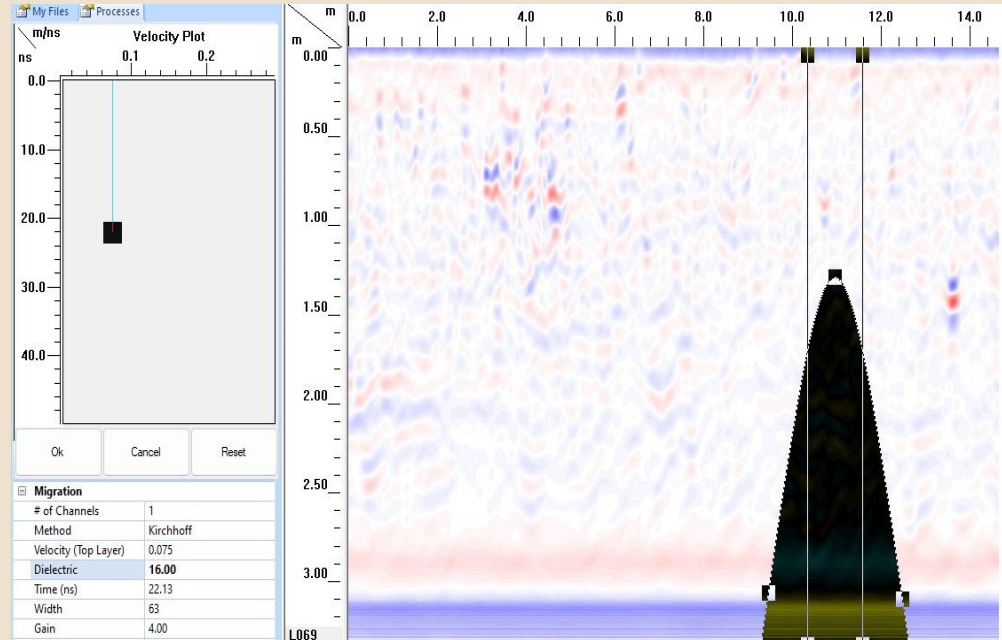


Figure 4. Screenshot from Radan 7 showing the velocity migration step of data processing using file L069m, which has a defined hyperbola.

Data

- Zoomed out image of Emory Grove Cemetery gives perspective on the area interpreted
- The gray box is the 3D GPR scan screenshot of Radan 7 from a bird's eye view
 - Red circle is two known graves (bright white spots)
 - Green circle signifies tree roots by the forested area (fainter white spots)



Figure 5. Image of Emory Grove Cemetery with 3D GPR scan screenshot from Radan 7 overlaid.

Data

- Zoomed out image of Emory Grove Cemetery gives perspective on the area interpreted
- The gray box over the survey area is the 3D GPR scan screenshot of Radan 7 from a bird's eye view
 - Red circle is two known graves (bright white spots)
 - Green circle signifies tree roots by the forested area (fainter white spots)

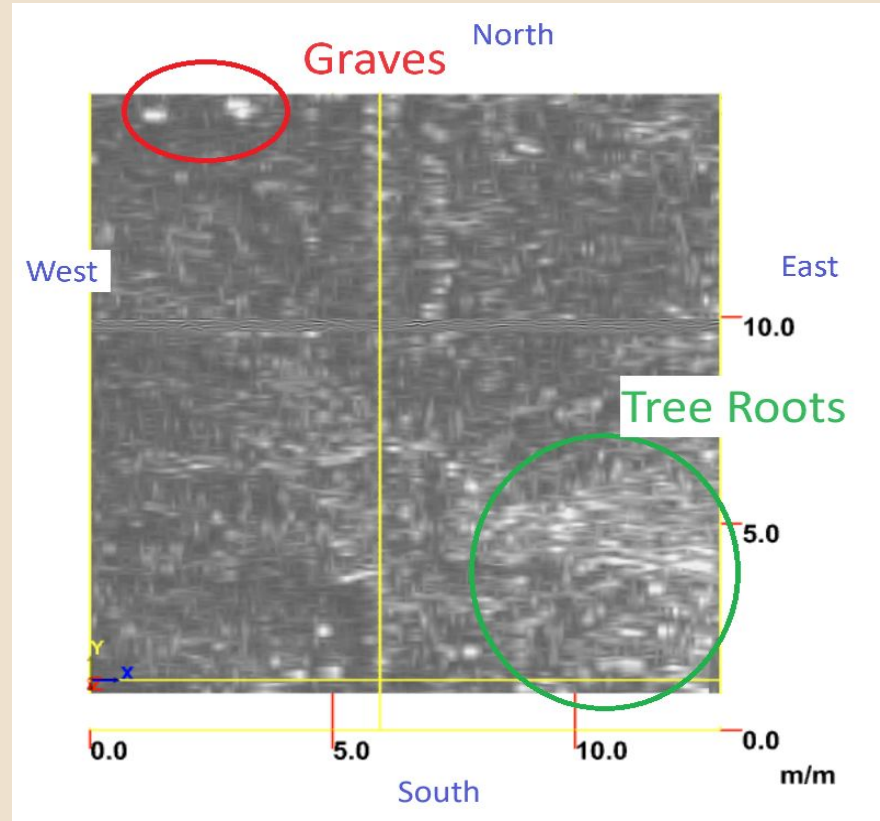


Figure 6. 3D GPR scan screenshot from Radan 7 (Bird's eye view).

Data and Interpretation

- Tilted image (z axis) of the Radan 7 3D GPR scan (south side)
- Green circles are where tree roots show
 - 4 hyperbolas ~1m depth (too shallow for a grave)
 - Aligns with large tree east of site and roots shown in bird's eye view
- Change in composition at 6m deep
 - Material above = clay?
 - Radar velocity (0.078 m/ns) is between the values at which clay presents (0.06-0.17 m/ns)
 - Maryland soil tends to be clayey and acidic
 - Below the white line is most likely alluvium soil, dominant in Maryland (Figure 1)

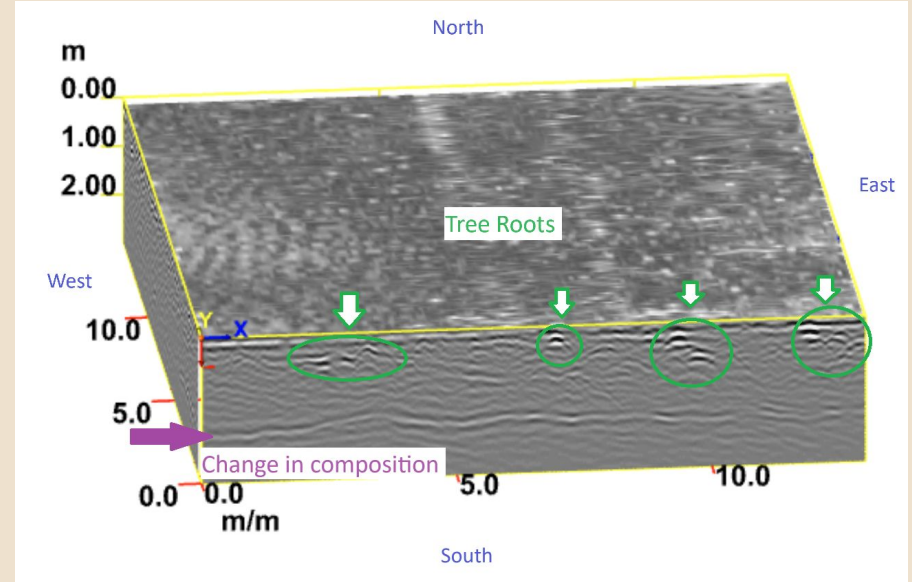


Figure 7. Tilted image (z-axis) of Radan 7 3D GPR Scan (south side)

Data and Interpretation

- Flipped image (south at top) amplifies z-axis image of two known graves at the northern perimeter (circled in red)
 - two bright spots in bird's eye view in Figure 6
 - graves typically present at ~2.5 m; same depth as hyperbolas shown
 - highly reflective white and gray bands align with definition of recent graves (groundpenetratingradar.com)

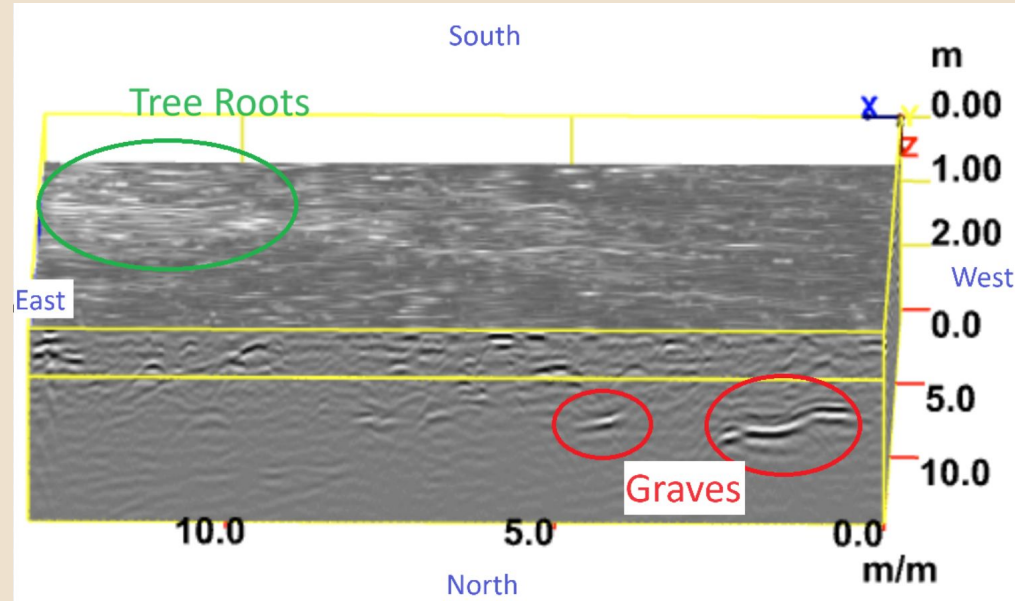
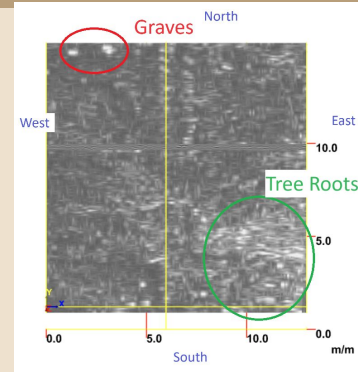


Figure 7. Tilted image (z-axis) of Radan 7 3D GPR Scan (North side).

Known graves are recent- what about older graves?

- older graves (50 to 100 years) produce less distinct or minimal grave anomalies
 - reflective white and gray bands are at a lower resolution
- issue resolved in data processing
 - applied a linear gain at 1.5 - 2.5m (typical grave depth) to amplify the fainter bands (Figure 3)

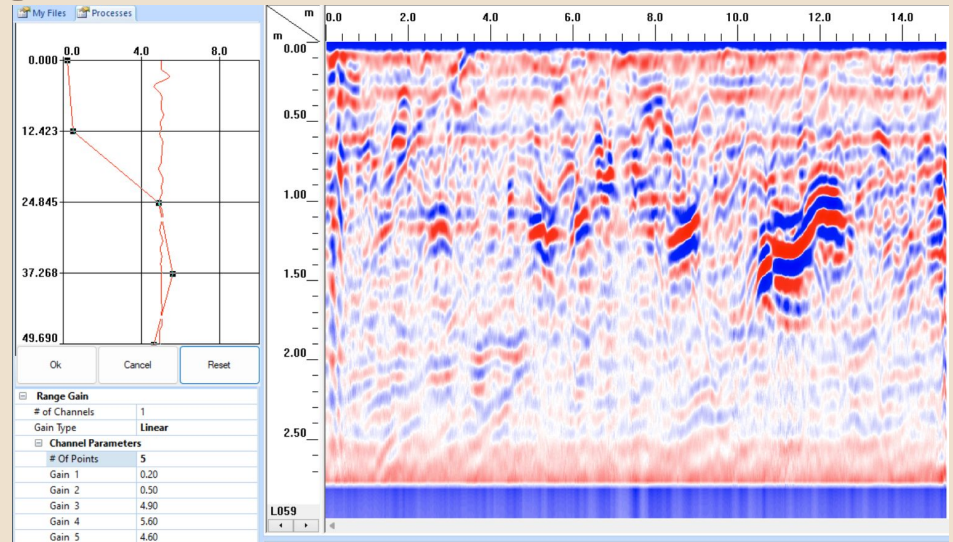


Figure 3. Radan 7 image with a linear gain applied to amplify the resolution of grave depth (~1.5m). The bright red and blue hyperbola from file L059 is the known gravesite near (0, 14.5)

Conclusions and Summary

Highlights

- Two types of anomalies :
 - distinct hyperbolas: marked graves
 - bright white spots: tree roots
- **No unmarked graves were found**
 - The cemetery does not need to be shut down

Future Work

- Further GPR work up to southern border
 - clear extensive foliage on forest floor
- Further GPR work toward eastern field of cemetery
 - first hand accounts of unmarked graves

References

- Adams, R. K. (2023), Geologic Map of the Gaithersburg Quadrangle, Montgomery County, Maryland, *Maryland Geological Survey*. Available from:
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- “Solar Flares - Saturday, 11 November 2023.” *SpaceWeatherLive.Com*, 2023, www.spaceweatherlive.com/en/archive/2023/11/11/xray.html.
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<http://www.groundpenetratingradar.com/howtolocategraves.htm>

Questions?