

GPR Investigations of the Roman Baths at Carsulae, Italy

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Carsulae

- In Italy north of Rome (Umbria)
- Founded ca 300 BCE
- Gained importance with building of ***Via Flaminia***, 220-219 BCE
- Many works constructed under Caesar Augustus, 27 BCE – AD 14
 - Arco di Troiana
 - Forum
 - Ampitheater/Theater
 - Baths

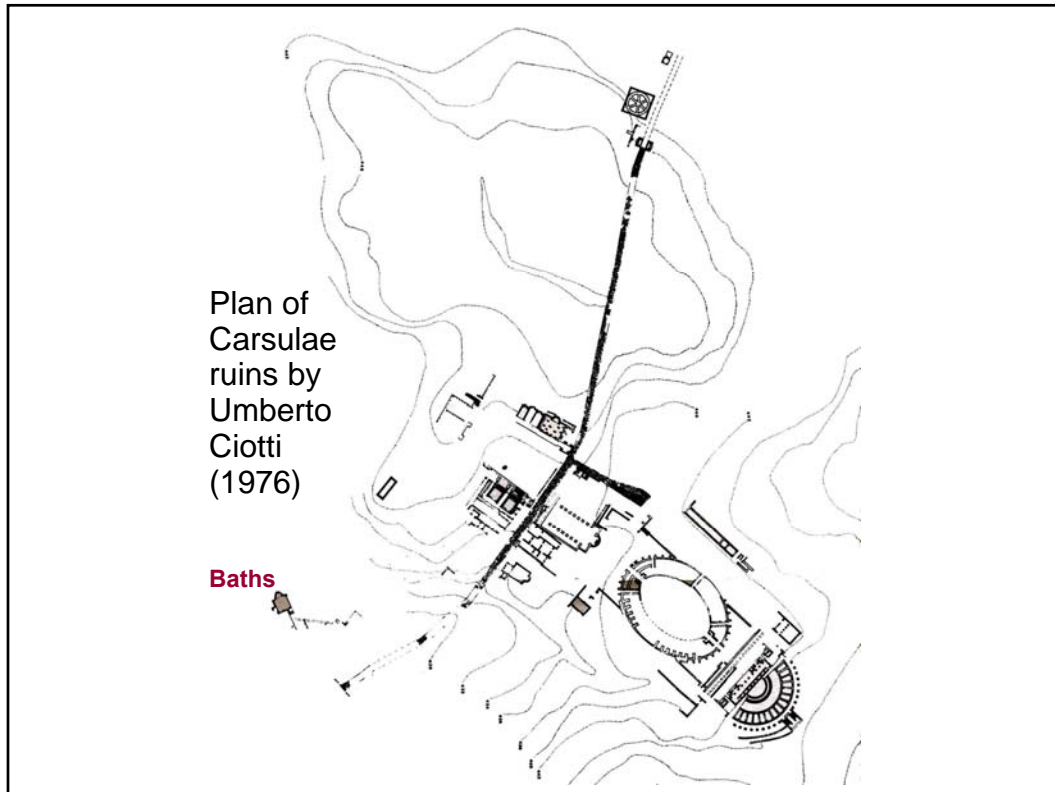






Carsulae Roman Baths

- Mapped and partially excavated along with other Carsulae ruins by Umberto Ciotti, soprintendente for Umbria from 1950s to 1970s
- Excavations by Dr. Jane Whitehead (VSU) began in 2004
- Field Season with GPR in 2011, prior to
- Roof constructed over Baths (2012)
- Reconstruction of Bath architectural details begun in 2014.





GPR of Carsulae Baths

- Thieme supervised fieldwork by project participants
- June 13 – July 1, 2011
- Malå 500 MHz GPR system
- mounted on rough terrain cart
- GroundVision 2 software on an old HP Omnibook
- 16 grids of GPR data, 13 from Baths



<u>GRID</u>	<u>Profiles</u>	<u>Direction</u>	<u>Began at</u>	<u>Samp Freq</u>	<u># Samp</u>	<u>TimWind (ns)</u>	<u>Tracelnt (m)</u>
CarBath1	6	W → E	NA	5118.8	452	88.3	0.303
CarBath2	19	E → W	Lower Right	5118.8	130	25.4	0.100
CarBath3	30	S → N	Lower Left	4993.9	222	44.5	0.017
CarBath4	21	E → W	Lower Right	5118.8	130	25.4	0.098
CarBath5	38	S → N	Lower Left	5118.8	128	25.0	0.098
CarBath6	12	S → N	Lower Left	5118.8	202	39.5	0.017
CarBath7	31	E → W	Lower Right	5118.8	202	39.5	0.017
CarBath8	25	S → N	Lower Left	5118.8	202	39.5	0.017
CarBath9	12	S → N	Lower Left	5118.8	202	39.5	0.017
CarBath11	21	W → E	Lower Left	5118.8	208	40.6	0.009
CarDol	2	NA	NA	3011.0	300	99.6	0.049
CarForum1	3	E → W	Lower Left	5118.8	202	39.5	0.009
CarForum2	11	E → W	Lower Left	5118.8	202	39.5	0.009
CarForum3	12	N → S	Lower Left	5118.8	202	39.5	0.009
CarShed1	1	E → W	NA	4993.9	456	91.3	0.009
CarShed2	1	E → W	NA	5118.8	530	103.5	0.049
CarShed5	18	N → S	Lower Left				
CarBathNS	1	S → N	NA				
CarVia1	2	W → E	NA	5118.8	80	15.6	0.017
CarVia2	15	N → S	Lower Left	5118.8	210	41.0	0.009
CarVia3	28	S → N	Lower Left	5118.8	350	68.4	0.017

GPR Data Analysis

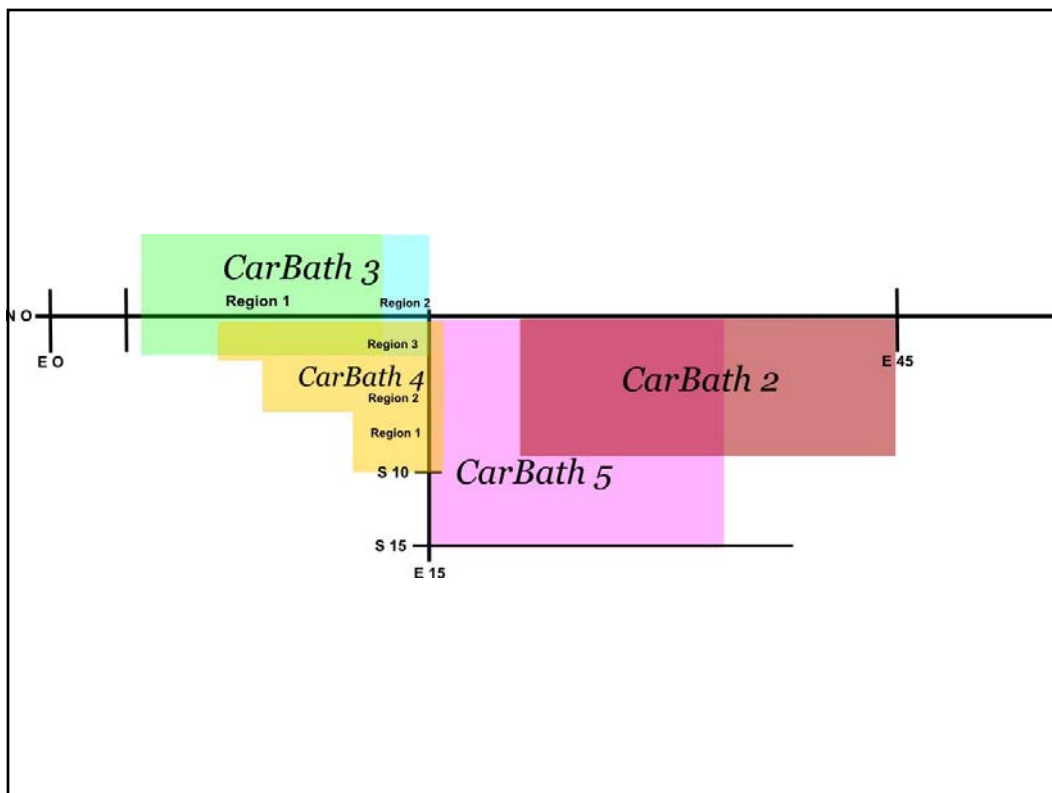
- Processing in San Gemini, 2011
 - Conversion to *.dzt
 - RadExplorer filtering for DC removal, Time Zero adjustment, Amplitude Correction
 - Inconsistent Use of Bandpass Filters and Deconvolution
 - GPR Process used to “time slice” CarBath2-9, CarBath11, CarForum2-3, CarVia2

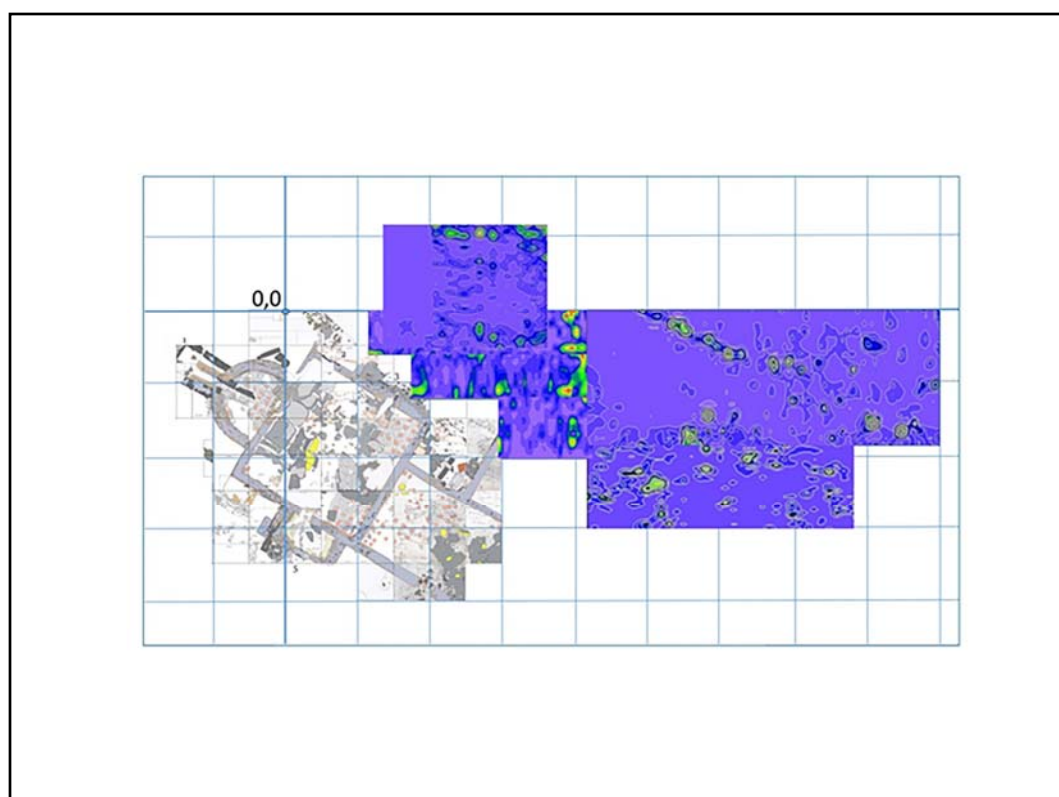
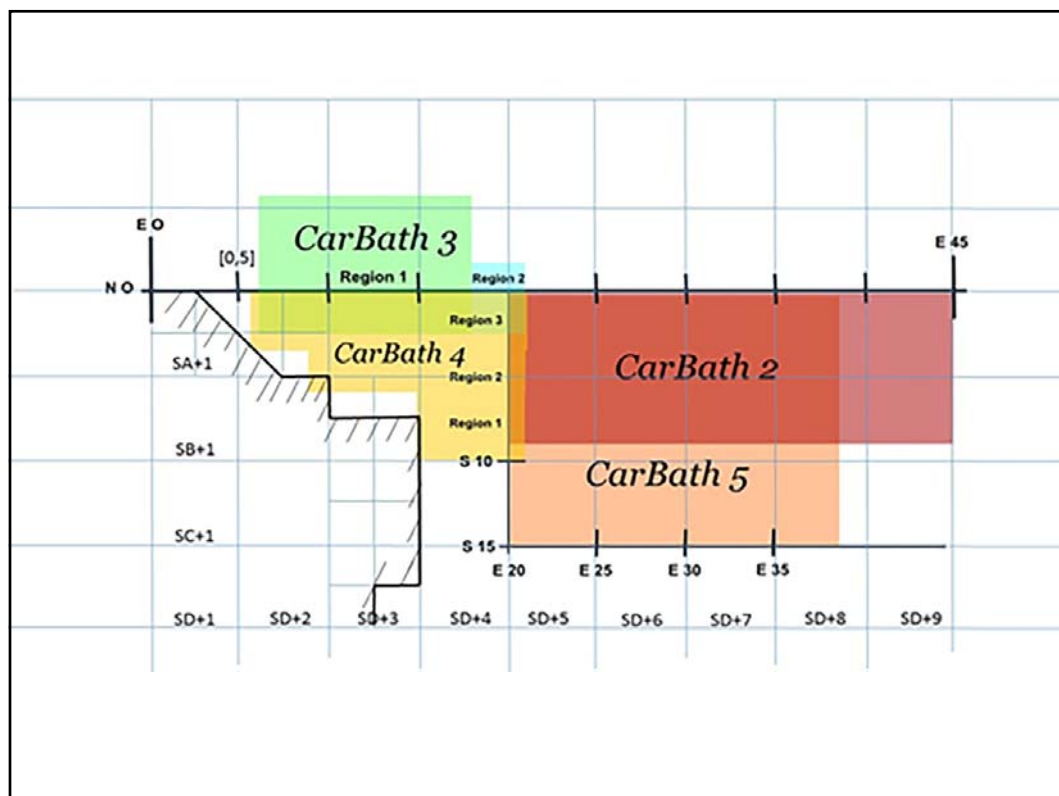
GPR Data Analysis

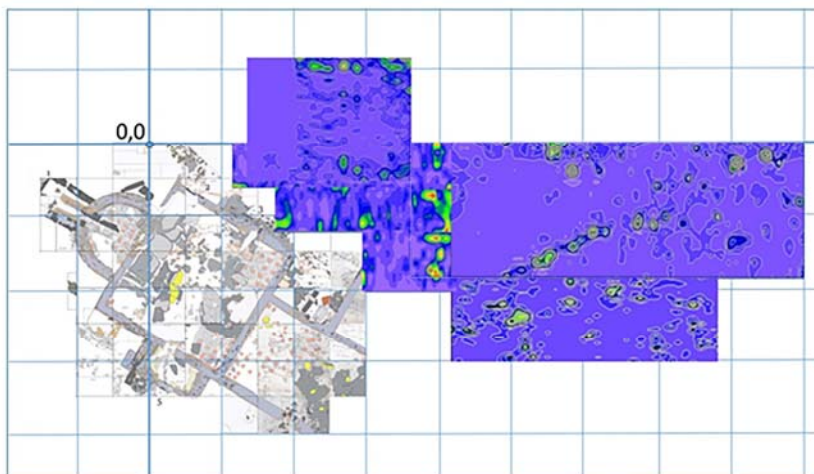
- Processing by Bruce Brown, 2016-2017
 - Thieme posted files for CarBath1-6 to
 - “<http://ww2.valdosta.edu/~dmthieme/Carsulae/CarsulaeGPR.htm>”
 - GPR Process used to time slice these 6 grids
 - Synthesis on common level of ~10 ns (80 cm bs @ 8 cm/ns)
 - TIFF images floated over CAD output of excavation site plan

Material	RDP	Velocity (cm/ns)
Air	1	30
Ice	3-4	16
Fresh Water	80	3
Salt Water	80	1
Dry Sand	3-5	15
Wet Sand	20-30	6
Shale and Clay	5-20	8
Silt	5-30	7
Limestone	4-8	12
Granite	4-6	13
(Dry) Salt	5-6	13

We used a velocity of **8 cm/ns** to estimate the depth in the time slice maps for Carsulae. The limestone rubble is conducting electricity a lot more rapidly than is the overlying or underlying loose sediment.

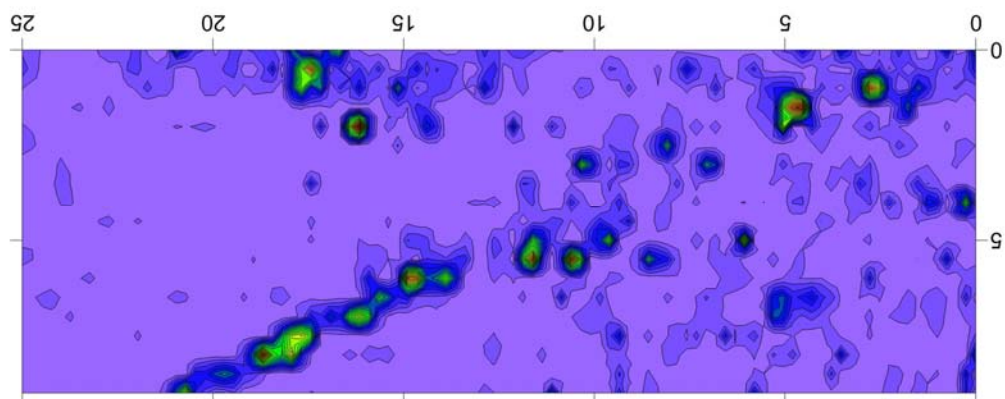


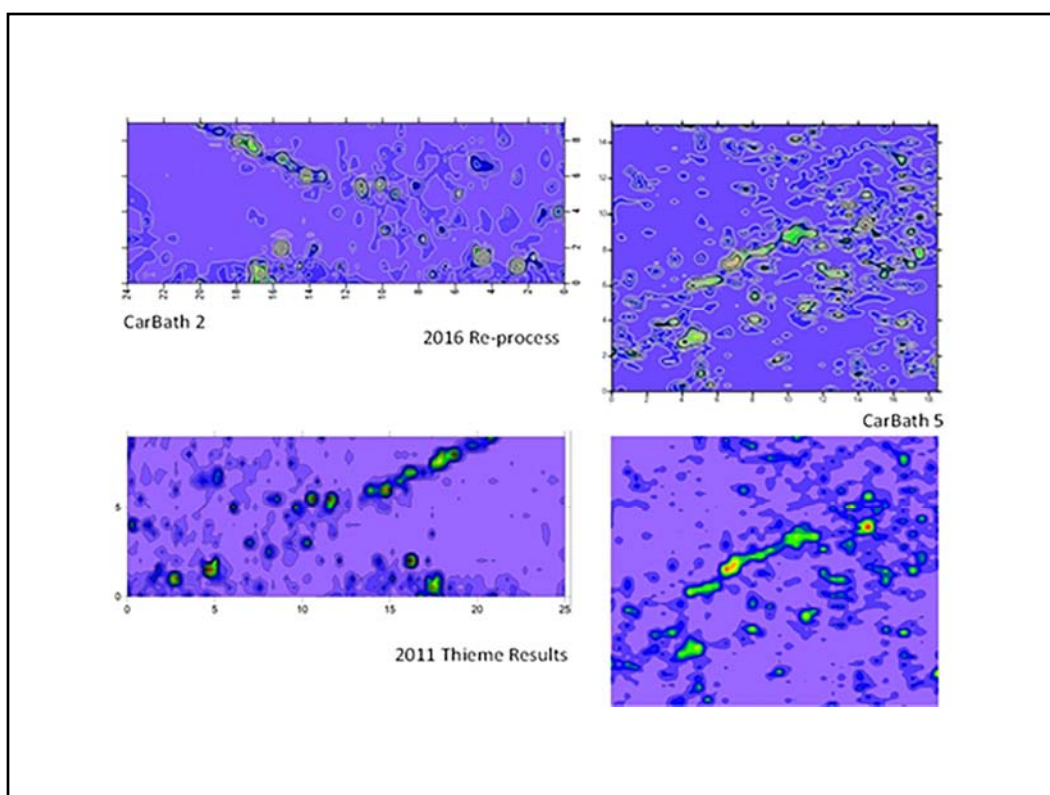
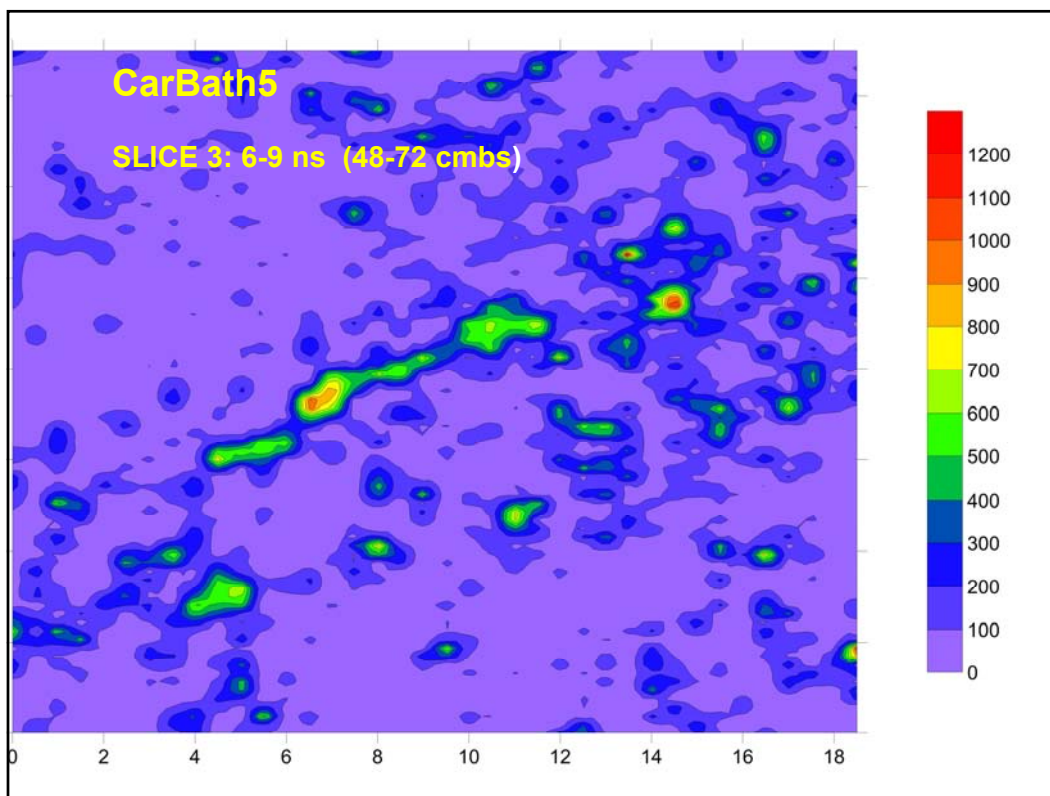


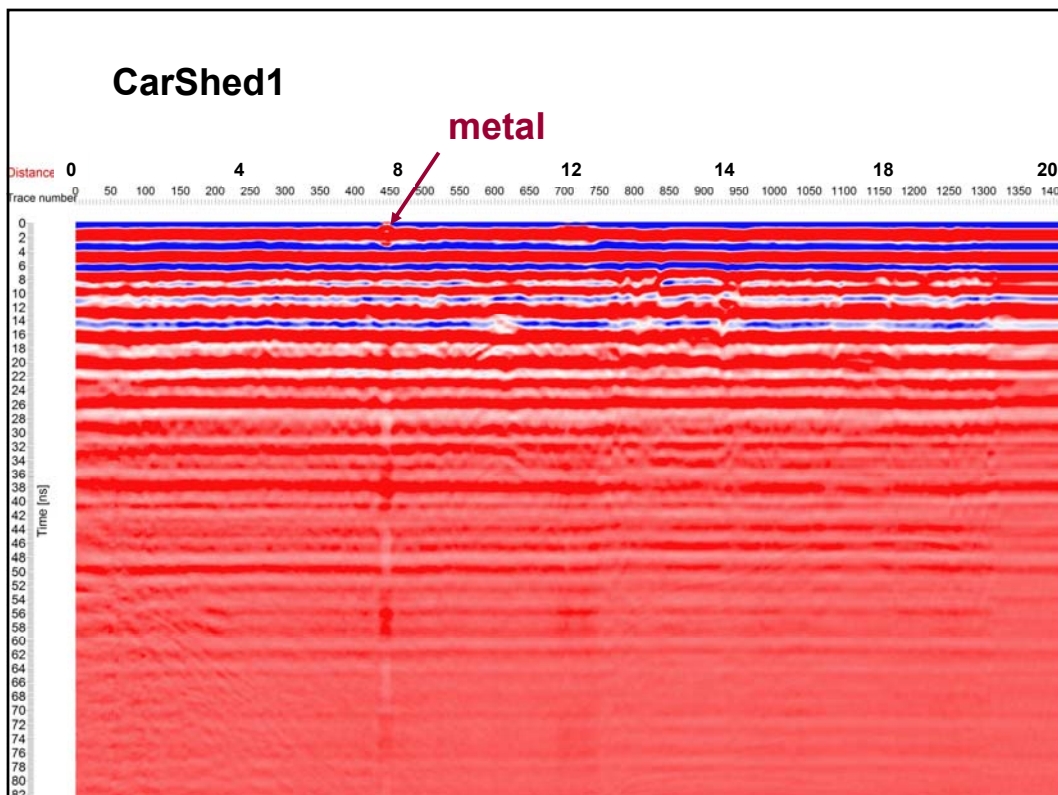


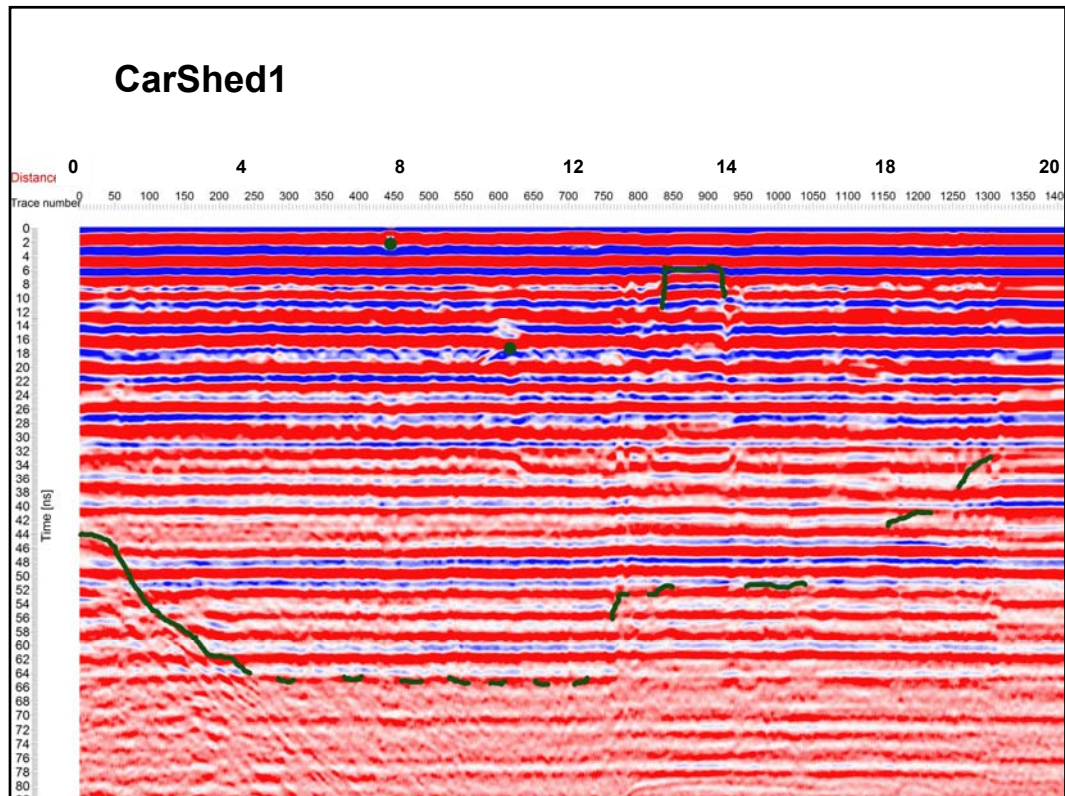
CarBath2

SLICE 4: 12-16 ns (96-128 cmbs)



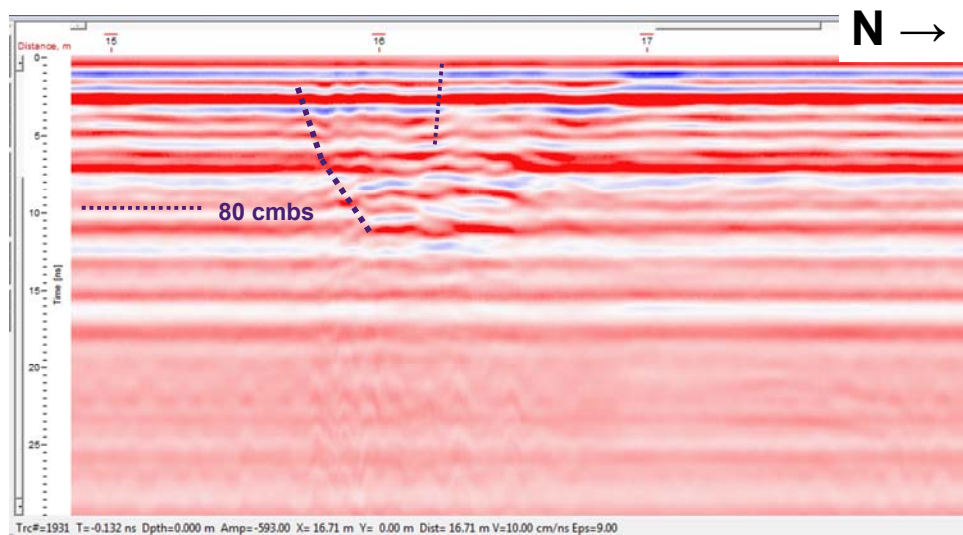








Ciotti trench (Forum)



Continuing Analysis

- Processing in GPR-Slice of raw data files for all 13 Grids from Baths
- At least 2-3 slices at common levels
- Correct CarBath2 overlay where lower right corner was grid 0,0
- Correct possible offset in overlay of all grids on project excavation plan
- Match linear anomaly running from Cistern toward Baths with excavated features

Continuing Analysis

- Combine CarBathNS profile with seismological analysis of cultural/natural contact beneath Baths and fill in Fossa.
- Possible application in Carsulae Archaeological Park to identification of Ciotti excavations, looting, etc...
- Paleohydrology
- Paleoseismology

