

Ground Penetrating Radar-New York



- Ed Stein October 2002



~~~~~NY-NRCS GPR EQUIPMENT~~~~~

** GPR CONTROL UNITS (3-OLD!)

GSSI -- SIR-3 (1) & SIR-8 (2)

* They have been prone to various breakdowns and operating problems.

**SIR-3* is the unit we use the most. It currently is in good condition, but can be temperamental depending upon weather conditions. It has required various repairs in the 2 years we have used it.

**SIR-8* takes longer to setup in the field and requires connecting more components. Currently, only one unit works as I have had to “borrow” parts from the other *SIR-8* (and an extra recorder) to maintain one working unit.

** Antennas: *300 MHz & 400 MHz* (new)

We have used ground penetrating radar for a variety of applications over the past 3 years.

-majority of our projects have been related to:

* *soil survey activities*

* *Farm Bill programs*

* *cultural resources/archaeological investigations*

some of our GPS projects include:

1. Chemung Co. Sand Project

► Purpose:

SWCD request:

To verify the soil mapping and determine quantity of “winter road” sand available on a farm.

•Results

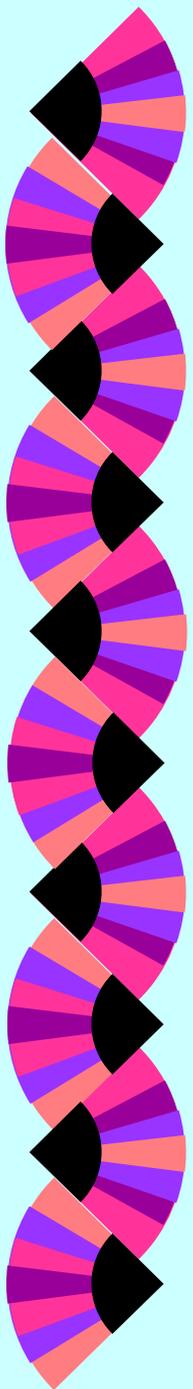
Radar profiles showed over 50 feet of sand in outwash areas (Chenango series), & in other places there was a thin ablation till mantle (Valois series) over the sands. Excavator pits were dug down to 20+ feet to verify the radar interpretations and soil materials.



2. Revolutionary War Era Battlefield

SITUATION: was asked if GPR could determine depth to bedrock and dip direction of sandstone & shale bedrock for a construction project in the park

RESULTS: radar showed this well -- *also* revealed a distinct near surface anomaly on a heavily used hiking trail -- a hole dug with tile spade showed it was moisture, density, and structure related due to severe soil compaction on the trail [**firm w/ thick platy material**] vs. a **WOODED** area <2 meters away that was friable & w/mod. granular structure & good porosity



3: Massena project:

GOAL: Determine thickness of sand over marine clays along the St. Lawrence River in northern NY

GPR RESULTS:

- * profiles showed moist sand 0-4.5 feet
- * “quicksand” 4.5 to 6.5 feet (water table)
- * marine clay 6.5 to 7+ feet
- * **signal attenuation in clay at about 7 feet**
- * GPR would have been helpful to identify and map out these soil materials & series. Marine clays and the potential for quicksand were not described in the soil survey for this area. Survey had been mapped mostly using a Dutch or bucket auger.

4. Depth to limestone bedrock project

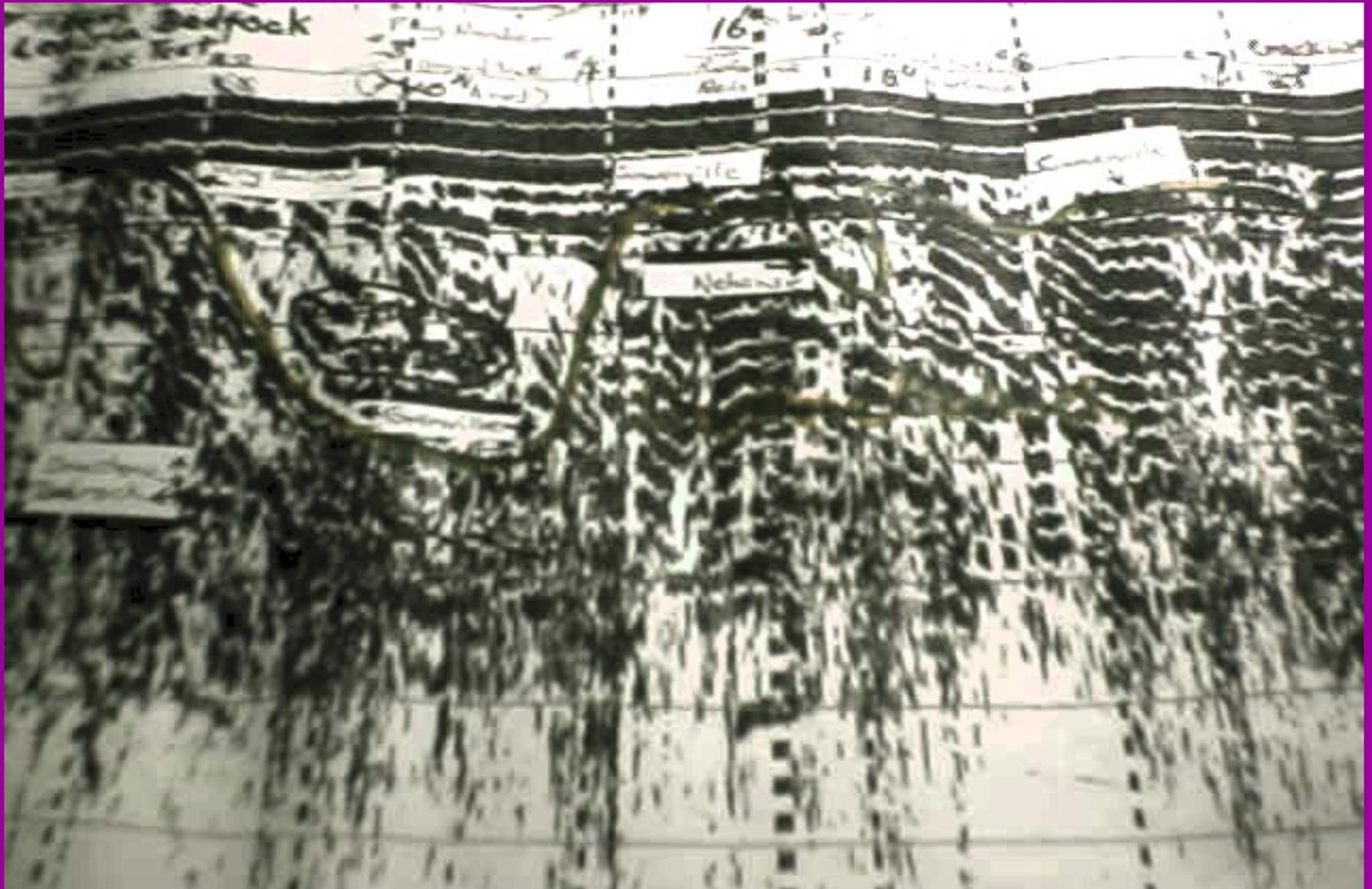
Lewis Co., NY Soil Survey

Purpose:

1. to check accuracy of old mapping especially the depth of bedrock
2. evaluate the potential of using GPR as a tool for routine mapping needs

Results: GPR permitted us to map out a number of soil series based on the depth to limestone bedrock

one of the GPR profiles



Lithic & Dystric Eutrudepts

14" TO BEDROCK
"GROUND TRUTH"

very shallow

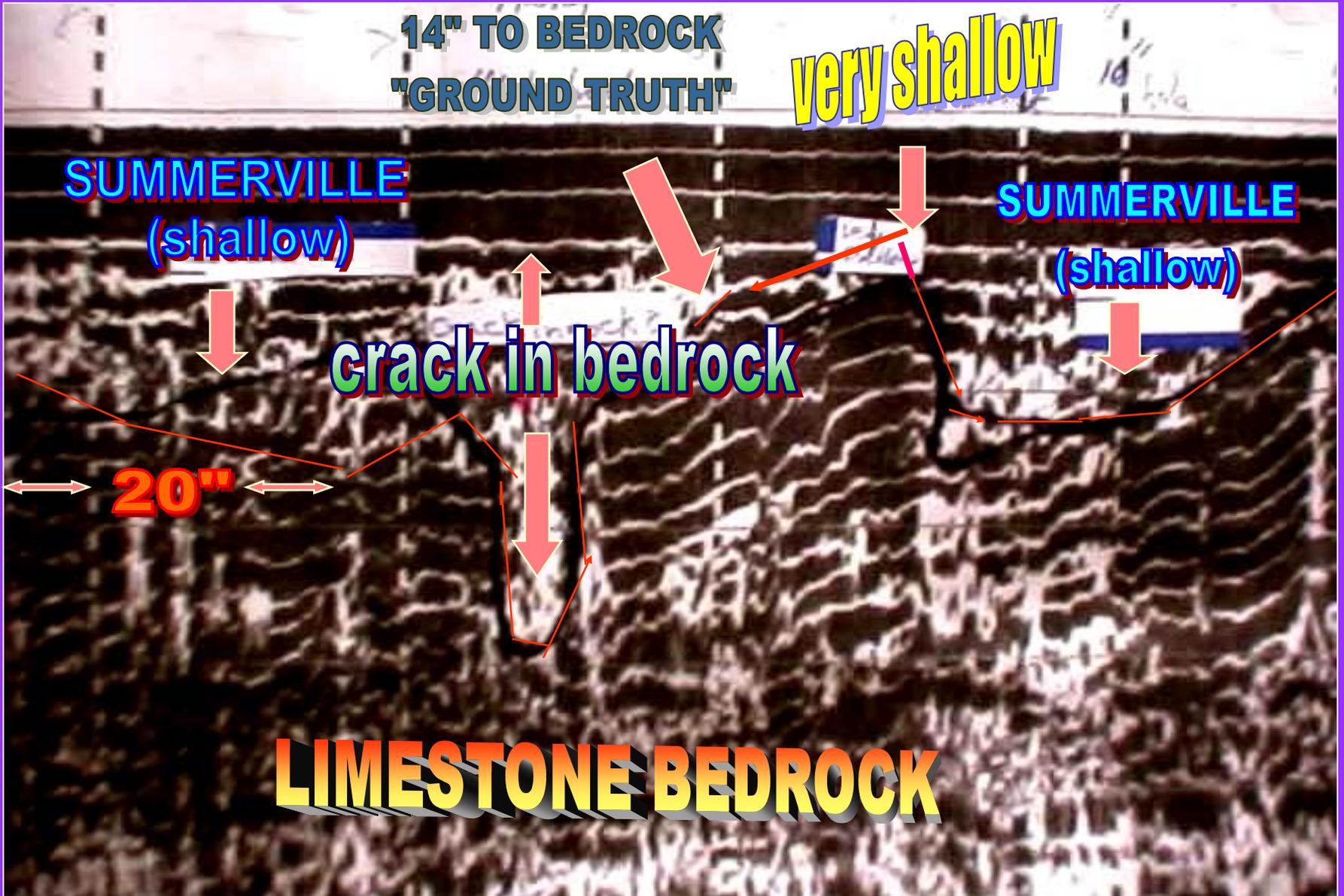
SUMMERVILLE
(shallow)

SUMMERVILLE
(shallow)

crack in bedrock

20"

LIMESTONE BEDROCK



outcrop

Summerville

Nehasne

Grenville
(Typic Eutrudept)

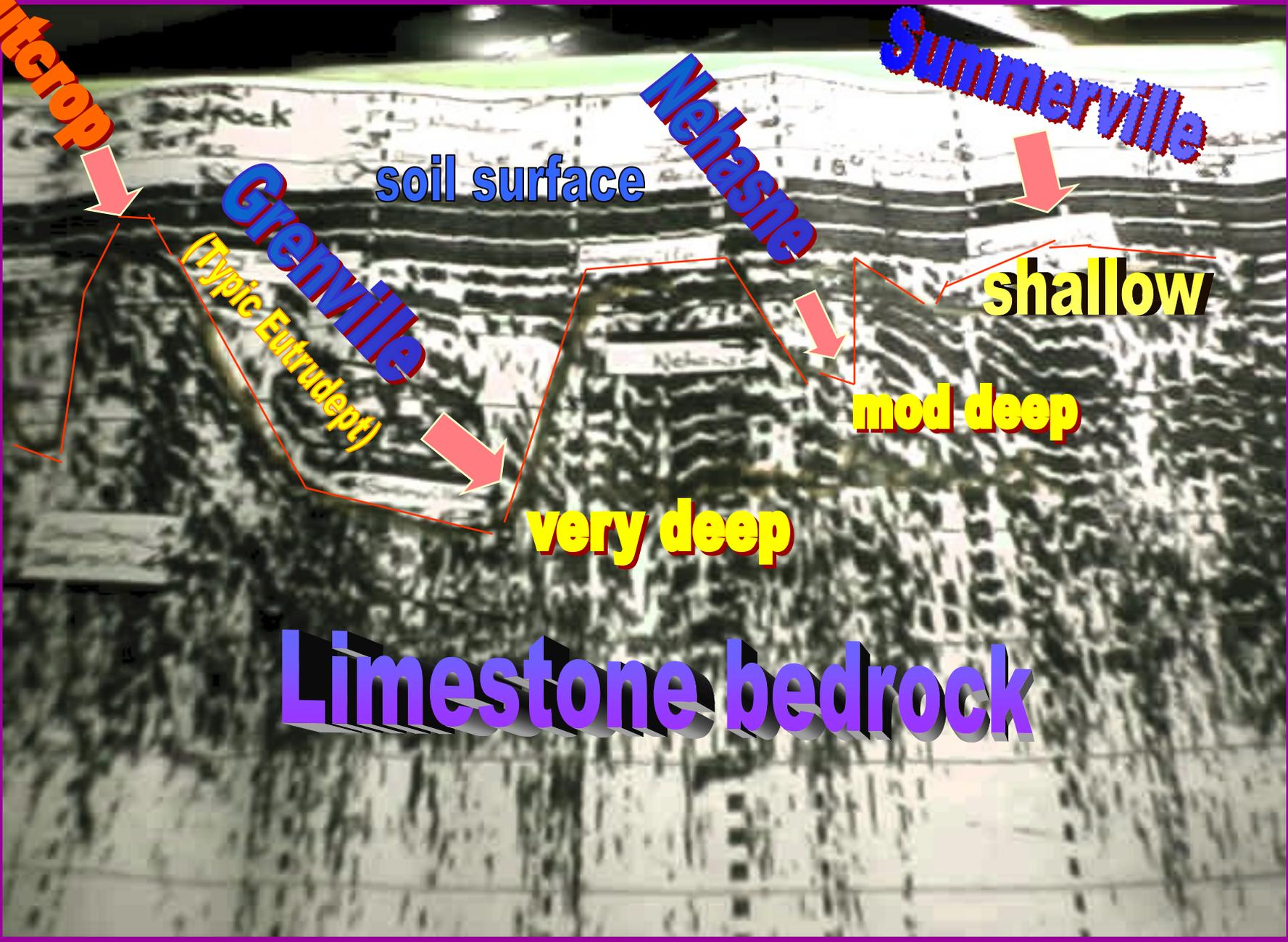
soil surface

shallow

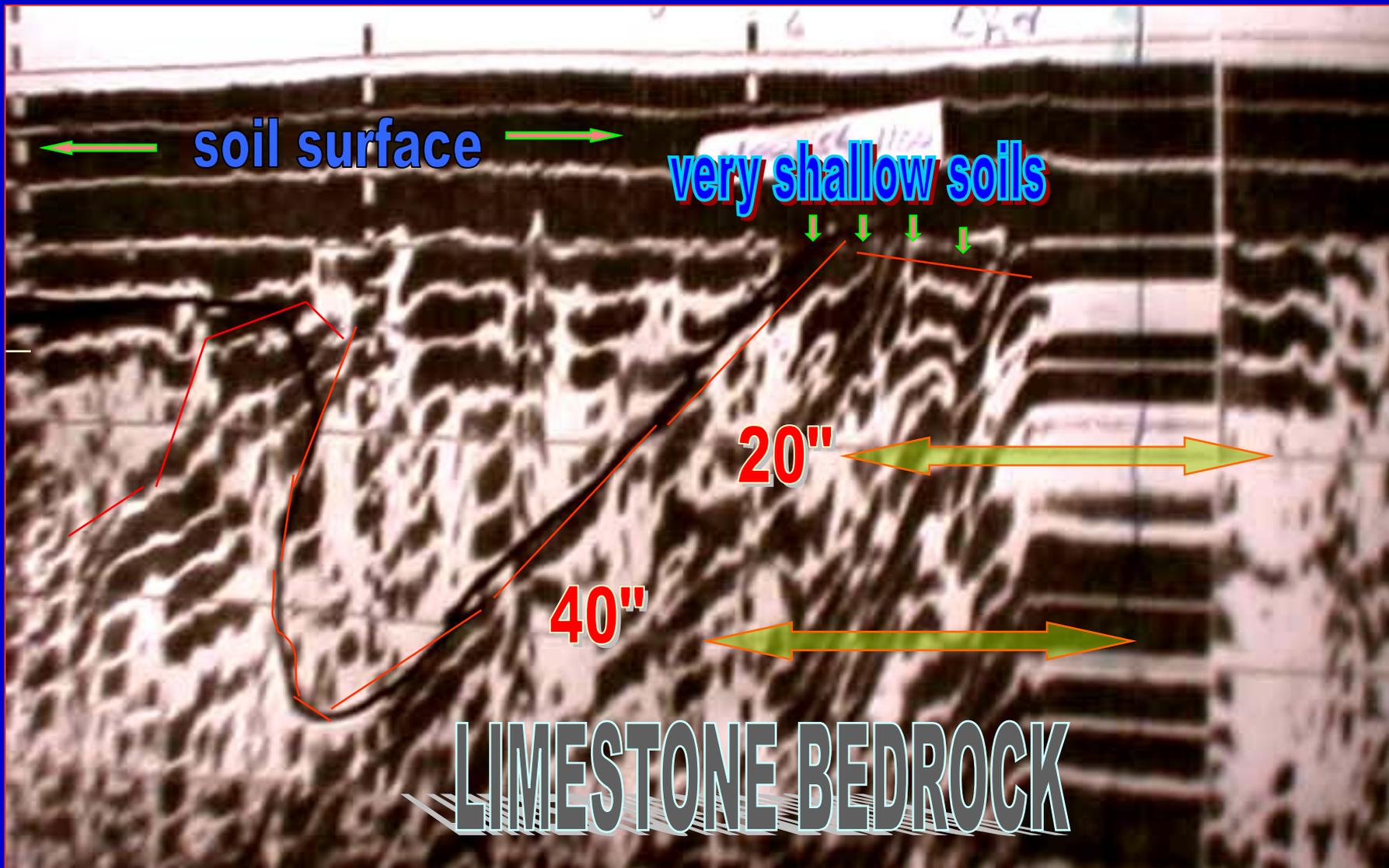
mod deep

very deep

Limestone bedrock



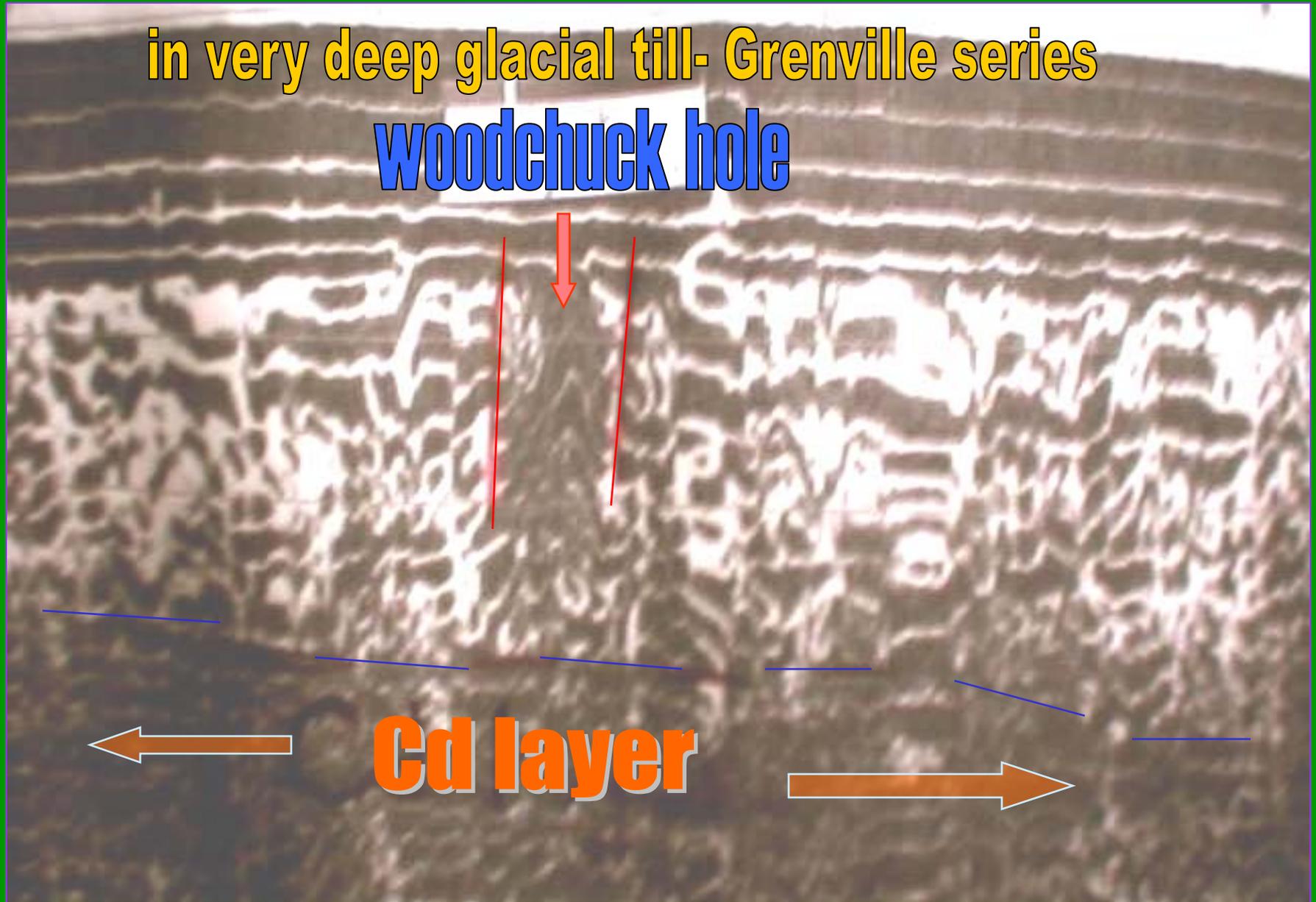
karst topography



Example of an Anomaly

in very deep glacial till- Grenville series

woodchuck hole



5. Archaeological investigation Herkimer Co. (for CRP project)

- ▶ **PURPOSE:** Landowner was interested in enrolling a parcel in *CRP* (adjacent to a lake)
- ▶ **Soils:** Honeoye, Appleton, & Lyons series (Alfisols)
- ▶ Native American burials were known to have been excavated somewhere in this vicinity in 1950's & longhouse remains were rumored to exist in the area
- ▶ **GPR Results:** was able to determine where the burials had been excavated; located potential area of undisturbed burials; & also found "refuse" areas (with artifacts) associated with a pre-Iroquois longhouse site
- ▶ **Outcome:** landowner withdrew this portion of the parcel from CRP enrollment & eliminated NRCS from potentially having to contract for a Phase 2 cultural resources survey
- ▶ (CRP contract now exists for the remainder of area that was offered)

CRP SIGN-UP AREA

paper sticking to the rollers



(hot & humid day!!)

Wainohta project- Weaver Lake

Lyons series

Weaver Lake

HYDRIC SOILS

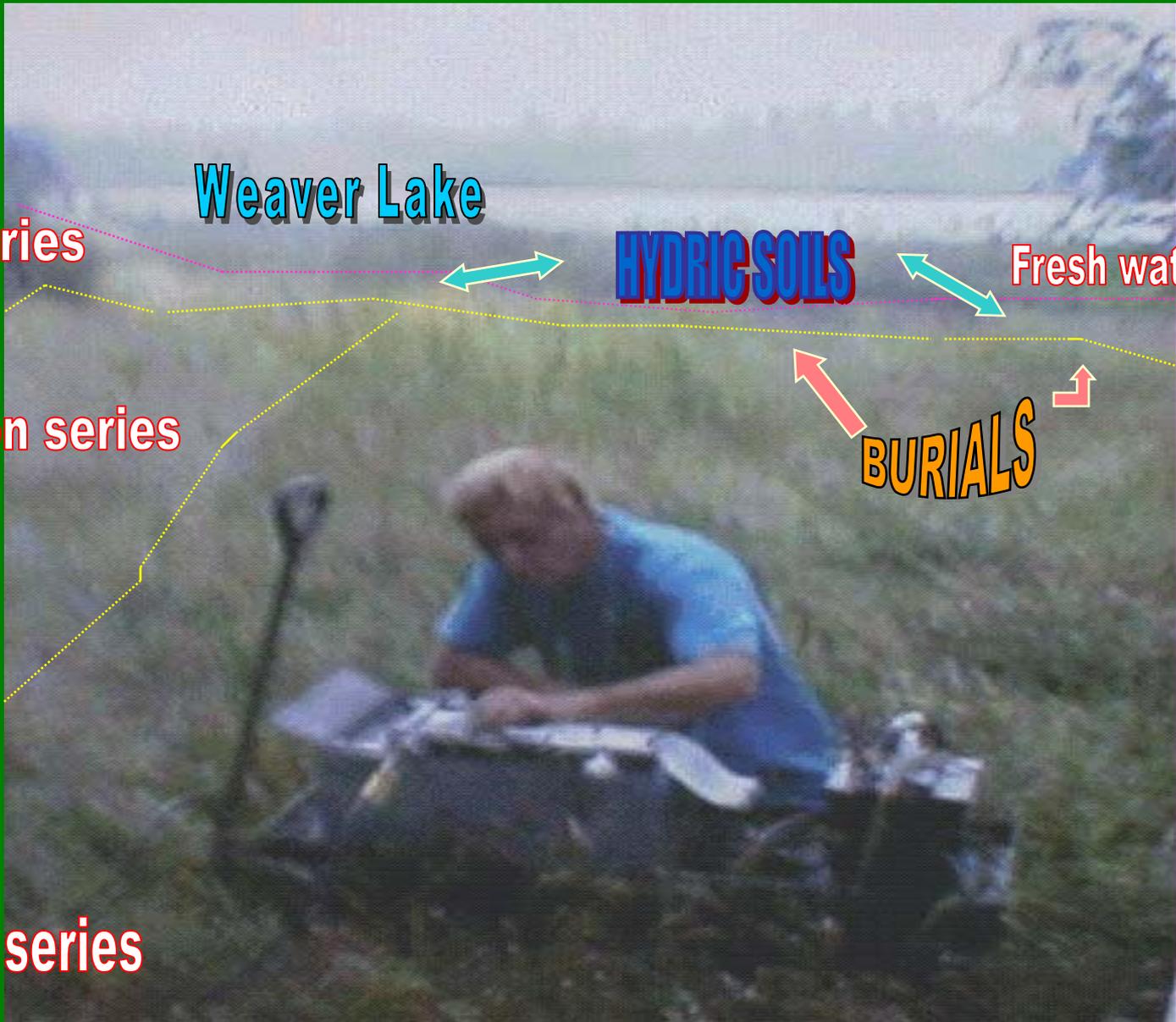
Fresh water marsh

Appleton series

BURIALS

Lima series

8/01/01



SIR-3 unit in operation

**12v marine battery
power supply:**



unit is mounted on a metal garden cart



400MHz antenna setup

Wainothen longhouse site



THE HARD PART ...
making profile interpretations



Several of the artifacts found by the landowner in one of radar anomaly areas (refuse pits).



6. Wetland Reserve Program (WRP)

- ▶ *Special WRP focus area in Madison Co.*
- ▶ **GOAL: Could GPR be used to determine the:**
- ▶ -thickness of remaining Oa horizon **in a drained & depleted area of organic (muck) soils**
 - ▶ **determined muck layer thickness could be mapped with GPR
 - ▶ **most areas were <40 cm and many areas <20 cm
- ▶ -presence & thickness of marl
 - ▶ **deposits ranged from a few cm to >10 meters in thickness
- ▶ -depth to water table
 - ▶ **determined to be about 9 meters
- ▶ -verification of soil mapping & where to make changes prior to SSURGO recertification

WRP Restoration Project

MARL & MUCK



anthropogenic marl soil



one of the soil sampling sites



Martisco series

0"

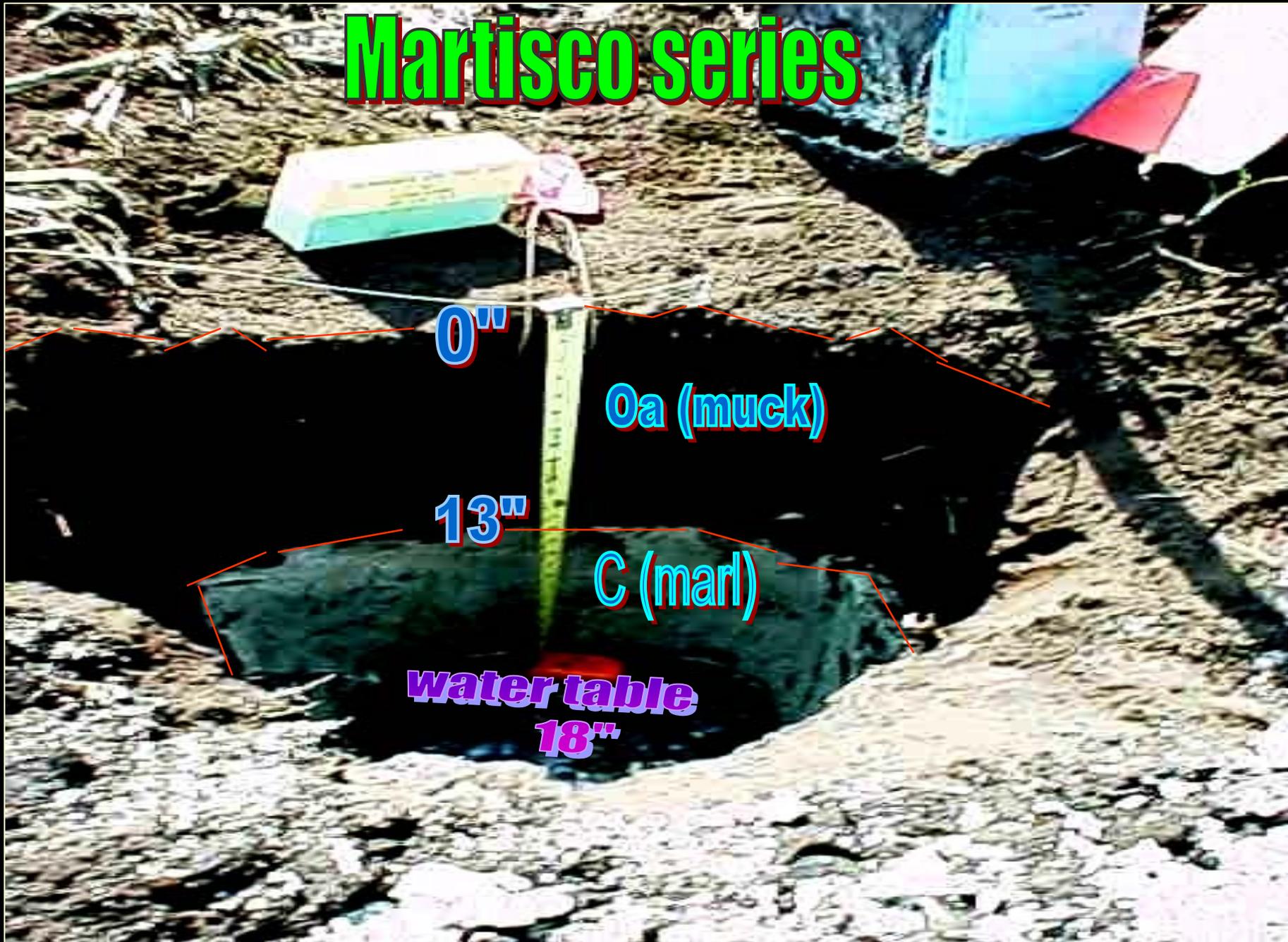
Oa (muck)

13"

C (marl)

water table

18"



7. Mabee Farm project

▶ **PURPOSE:**

- ▶ 1. to locate rumored 1600-1700's slave burial grounds
- ▶ 2. locate presence of subsurface anomalies that may be of archaeological significance (mainly looking for historical)
- ▶ 3. determine soil layers

▶ **LOCATION:** low terrace of the Mohawk River prone to rare flooding until 1930's- now it's somewhat protected/controlled (due to canal)

▶ **SOILS:** soil survey shows a large glacial outwash map unit of the **Howard** series (loamy-skeletal, mixed, active, mesic Glossic Hapludalf)

▶ ** radar profiles show entire area has a silty or loamy mantle overlying the gravelly outwash (mantle > 24" & of varying thickness)

▶ [coarse-loamy and coarse-silty over sandy-skeletal]

▶ ** a future soil survey update- should consider remapping area with a new series or possibly using Copake, Agawam, or Palmyra

Mabee Homestead from 1600's



**400 MHz
Antenna**

30m tape for grid

Mabee farm "the Dutch barn"

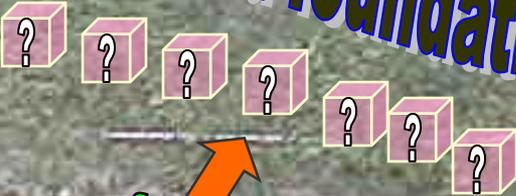


looking for the original Dutch barn foundation



SIR-3 →

buried foundation?



GPR profiles indicate some type of
subsurface anomaly pattern

8. Mt. Hope Cemetery-Ticonderoga, NY

Purpose: To determine depth to bedrock since hand auger holes were inconclusive.

History: has been a cemetery since the 1860's (with poor burial records)
-site of several forts during French & Indian War & Revolutionary War
*GPR may have located a mass grave associated with a British Fort

Soils: ** hilltop-- thin lacustrine clay deposits over bedrock

(**Farmington** series: loamy, mixed, active, mesic, Lithic Eutrudept)

(**Galway** series: coarse-loamy, superactive, mesic, Typic Eutrudept);

**hillsides-- very deep lacustrine clay deposits with argillic horizons

(**Vergennes** series: very-fine, mixed, active, mesic, Glossaquic Hapludalf)

(**Hudson** series: fine, illitic, mesic, Glossaquic Hapludalf)

Results: Radar profiles clearly show the bedrock and many burials!

* have established reference radar burial profiles from the site

*can estimate soil depth & relative age of burials due to differences in burial techniques, collapse features, concrete vault liners, etc

SIR-8 setup Ticonderoga, NY



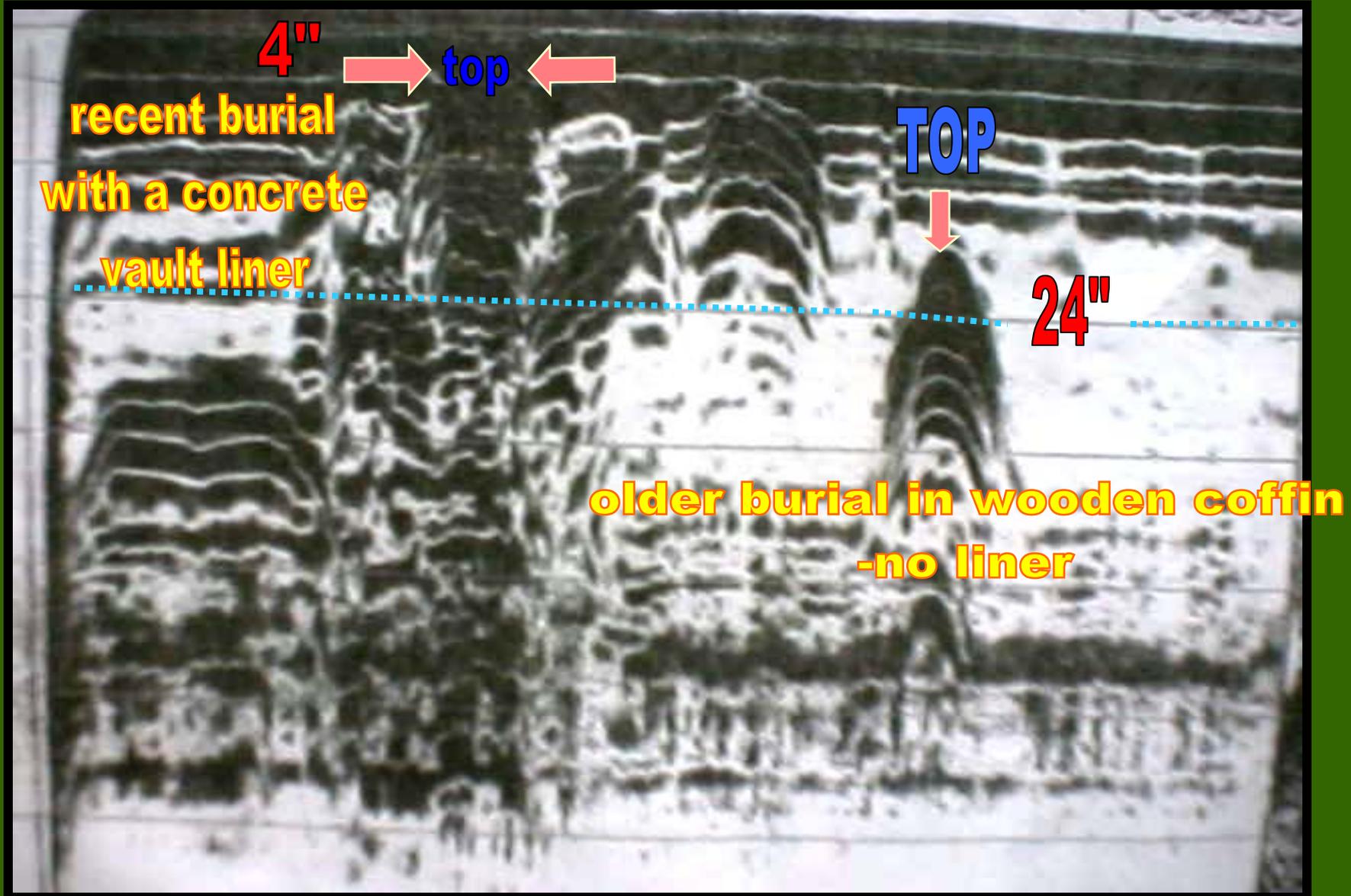


Some reference radar profiles
developed from this cemetery:

Reference burial profile - Mt. Hope Cemetery



multiple shallow burials (60ns)



AGE REFERENCE BURIALS

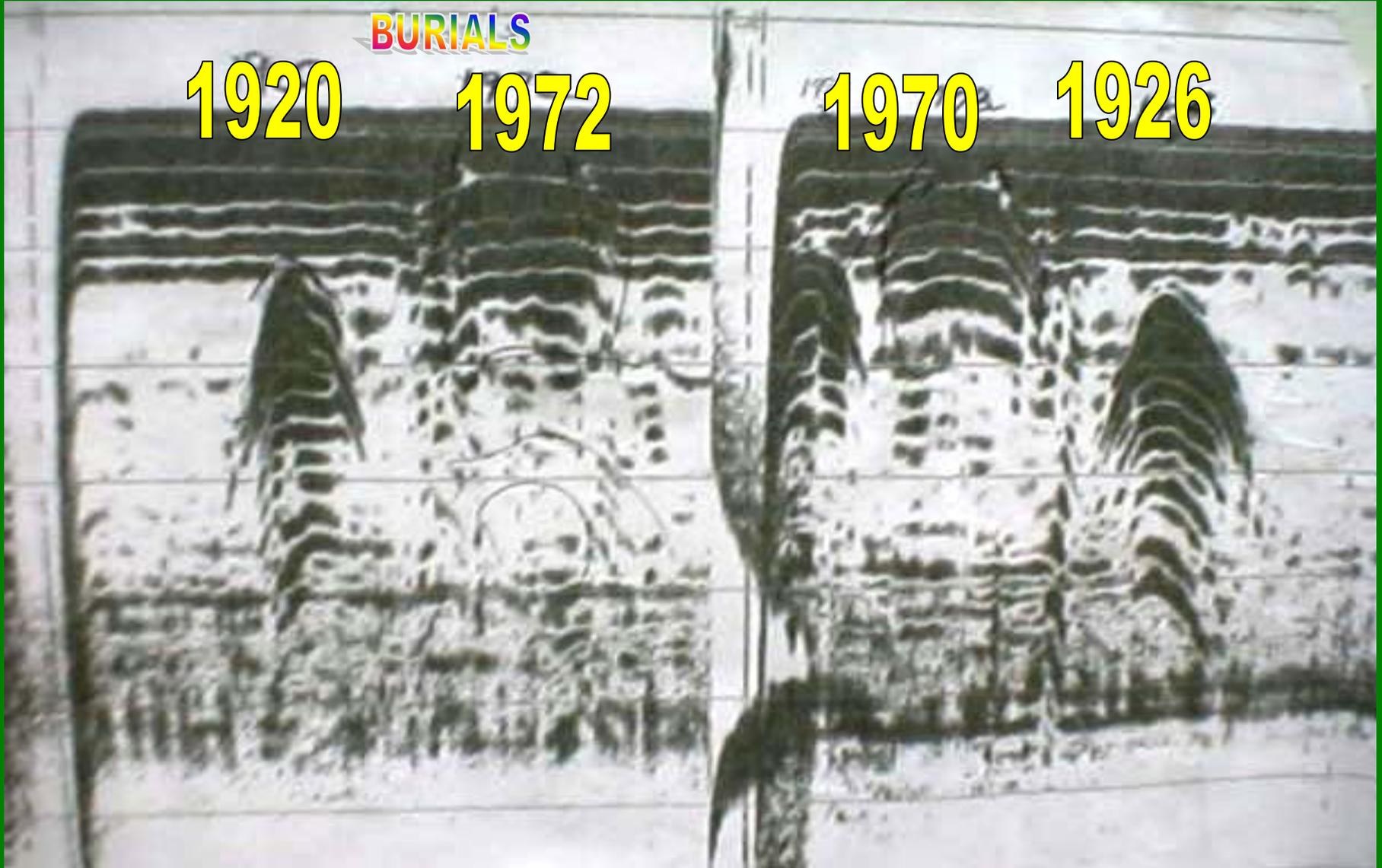
BURIALS

1920

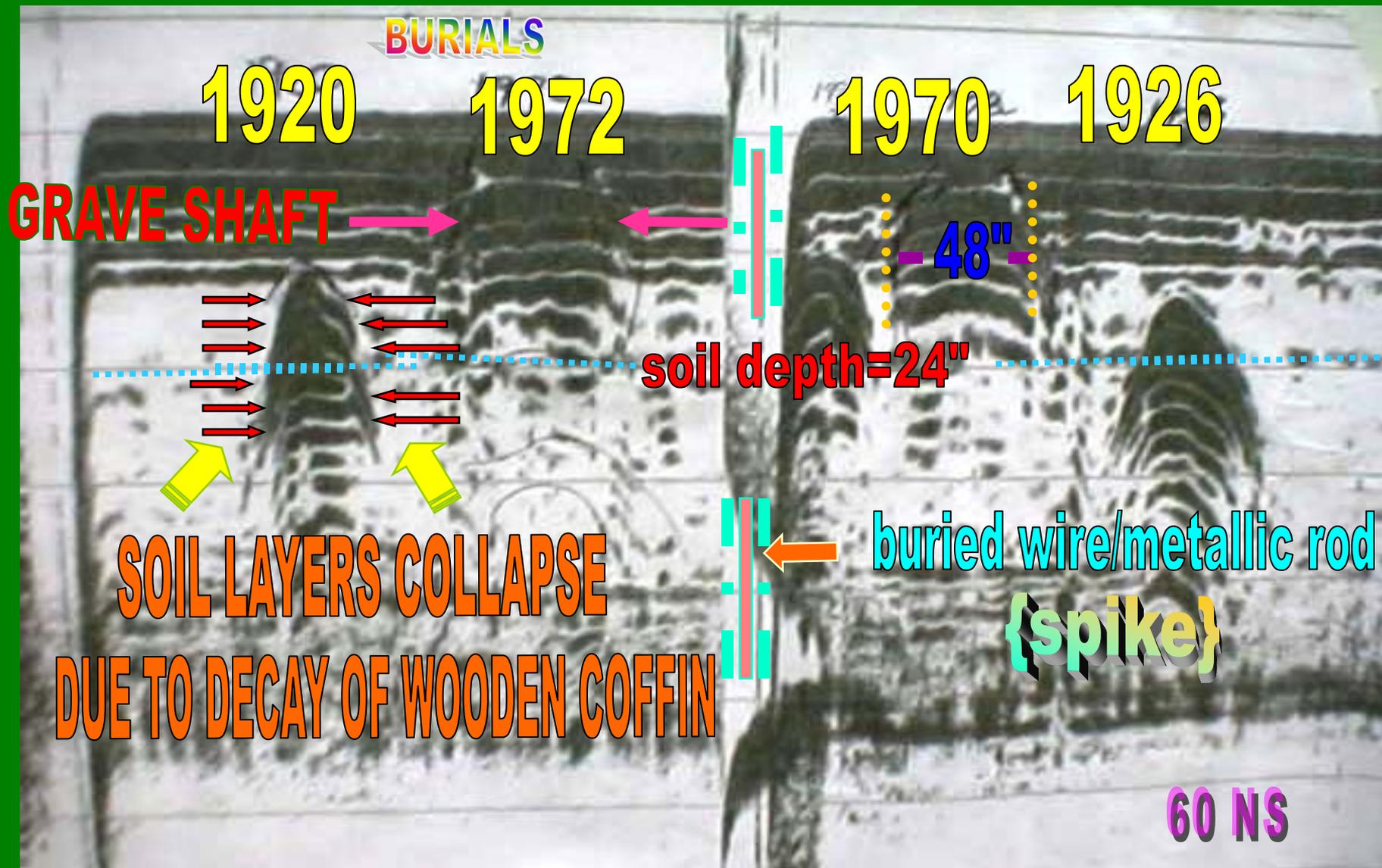
1972

1970

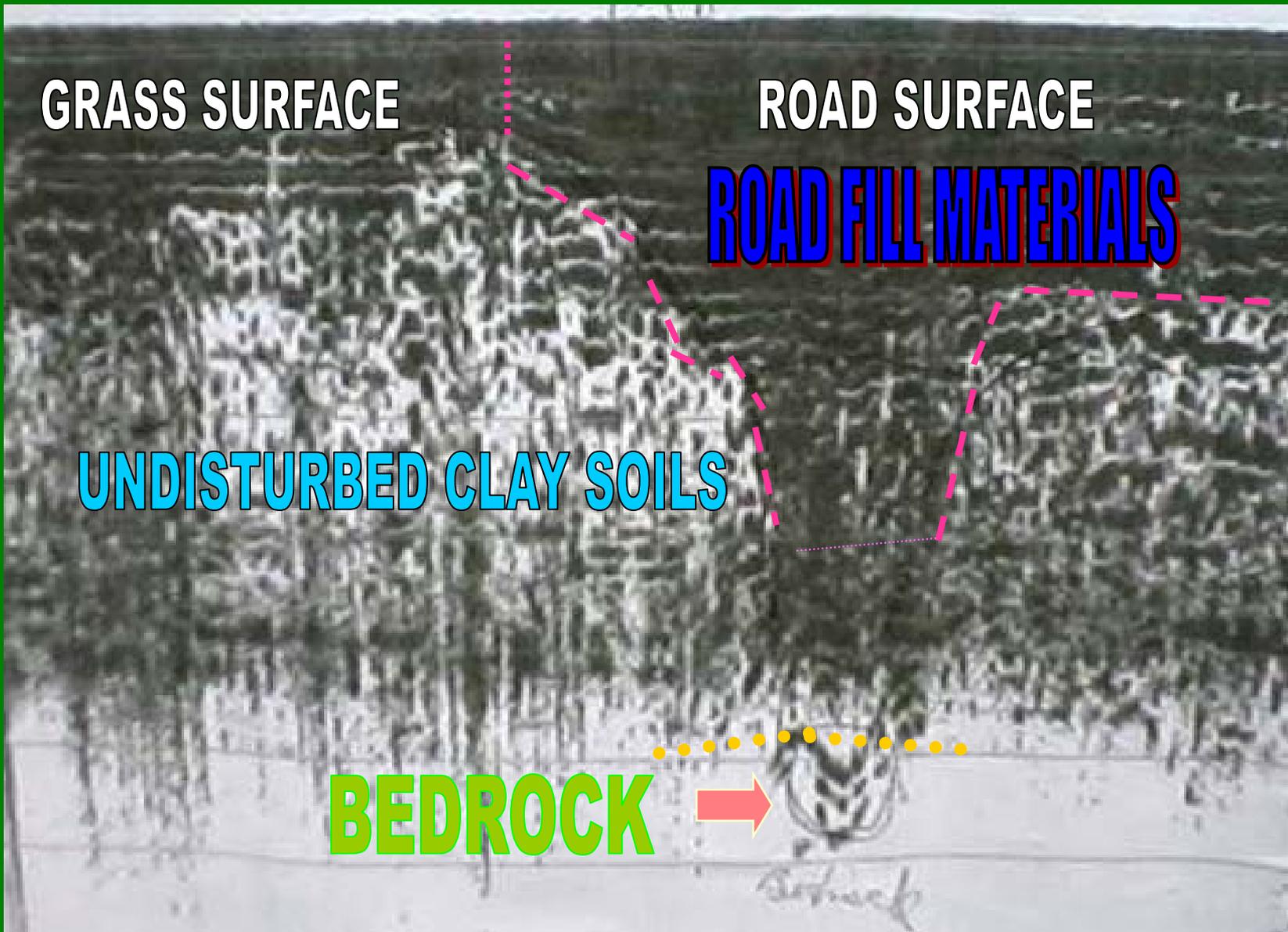
1926



AGE REFERENCE BURIALS



LOOKING FOR POTENTIAL BURIALS UNDER A ROAD



9. Murder investigation

Purpose: Originally this was an RC&D project working with one of the local Indian Nations. They had made a request for NRSC to provide some soils training for a group of students, and if possible, help locate an unmarked historical Native American burial ground (as mentioned in old documents and treaties).

**** In 2001-** GPR was used to locate a number of anomalies and subsurface soil disturbances in the training area. Many features were related to the farmstead that had existed there until a few years ago. However, several anomalies appear to be burials.

***One feature was very unique!!** My interpretation-- this area contains multiple burials & that a child is buried adjacent to and slightly above an older burial of an adult.

**** In 2002-** I was asked to provide additional GPR assistance at the site. When I arrived, I was greeted by various police agencies conducting a 20 year old murder investigation. They had been given my radar profile and felt the “child” may actually be the remains of a dismembered teenage murder victim. The suspects are rumored to have hid the victim in an existing grave in this vicinity.

Police also asked if our GPR and EM equipment could help locate the car used during the crime. It was thought to have been dumped into a nearby shallow pond which had been filled shortly after the time of the crime. Later the area was paved over for a parking lot.

Results: GPR located 3 potential spots in the parking lot- one was of particular interest using the EM-38. Police and forensics people have dug the “hot” spots and confirmed this was an old pond. They found car-sized objects at all 3 locations, even down to a depth of 12 feet, but not the actual car. Items include: metal storage shed w/ concrete foundation, large hot water heater, and a large pile of old car parts & junk metal.

The FBI recently reran the BURIAL spot with their GPR equipment. They agree with my interpretation that this area may be the “lost” burial grounds. Shortly, they are going to dig up my unique 3' x 7' soil disturbance feature, but feels it only contains one burial & at about 2' below the surface.

Some GPR Project Failures

-unable to determine depth of organic soil and presence of coprogenous earth in the drained "mucklands" of Orange Co.

-unable to determine depth to stratified gravels in a hayfield adjacent to a large gravel pit-- the soil was fine-loamy glacial till in the upper part (with a good argillic subsoil horizon) overlying outwash deposits

-unable to determine soil depth on Staten Island in a serpentine bedrock controlled area- no signal penetration

CONCLUSIONS:

- *Success of our radar studies have varied-- it works well in some areas and not at all in others!

Problem soils:

- *some clays-signal quite often attenuates in soils with a good argillic horizon and some lacustrine deposits

- *some organic soil deposits- no signal penetration in some soils

- *some crystalline bedrock areas-(especially serpentine) little penetration

Other problems/concerns

- potential for mechanical equipment failure at any time

- profile interpretations can be very difficult to evaluate especially where you can not establish a reference depth scale or ground truth any soil interfaces or anomalies

- changing paper and belts can be a hassle in the field

- most sites require practice runs & calibration adjustments before the unit is ready to be used

- with our equipment it can be difficult to conduct some projects with just one person because:

- * the 30 meter transducer cable can easily get tangled or snagged on vegetation

- * pulling 300MHz antenna & unloading the control unit, battery, field cart etc. (relatively heavy)

- * someone needs to watch the profile coming off the printer & mark locations of anomalies

- the 400MHz antenna works well for most of our project needs & is easier to use than the 300MHz but the trade-off is it only covers a 12"x12" area and provides less penetration depth

- ▶ *We would be utilizing GPR for more of our soil survey activities and other USDA programs if we:
 - ▶ 1. had more reliable equipment
 - ▶ 2. had additional operators trained in making interpretations
 - ▶ 3. had modern equipment along with some interpretation software
- ▶ * **Short term plans:** continuing providing GPS assistance on a limited & selective basis using present equipment and operator (s) for as long as the equipment functions and we are able obtain and afford the required repairs & supplies (belts & paper)
- ▶ * **Long range goal-** obtain a better control unit or purchase a new unit if the budget would ever permit
- ▶ -----
- ▶ new SIR-20: GSA price \$26,000 includes control unit, Toughbook computer preloaded with RADAN NT & 3D Quickdraw software
- ▶ new SIR-3000: GSA price \$13,135 includes control unit only with minimal processing capability

THE END

