THDC India Ltd.

International Conference on
HYDROPOWER AND DAMS DEVELOPMENT FOR WATER AND ENERGY SECURITY – UNDER CHANGING CLIMATE

New Delhi
Central Board of Irrigation & Power

INCOLD
Indian National Committee on Large Dams

IMAGING OF DEEP KARST USING THE MULTI-ELECTRODE RESISTIVITY IMPLANT TECHNIQUE (MERIT) CASE STUDY OF A DAM IN FLORIDA

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PARSAN

- Only company in India providing complete dam geophysical solutions (>70 dams investigated)
- Highly experienced and trained staff.
- Offices in Delhi, Bhopal, Kolkata, Bahrain, Saudi Arabia (Associate).
- Work experience in India, Nepal, Bhutan, Bangladesh, Singapore, Oman, Afghanistan, Saudi Arabia, Bahrain, Kuwait…….

About Speaker (Dr. Sanjay Rana)

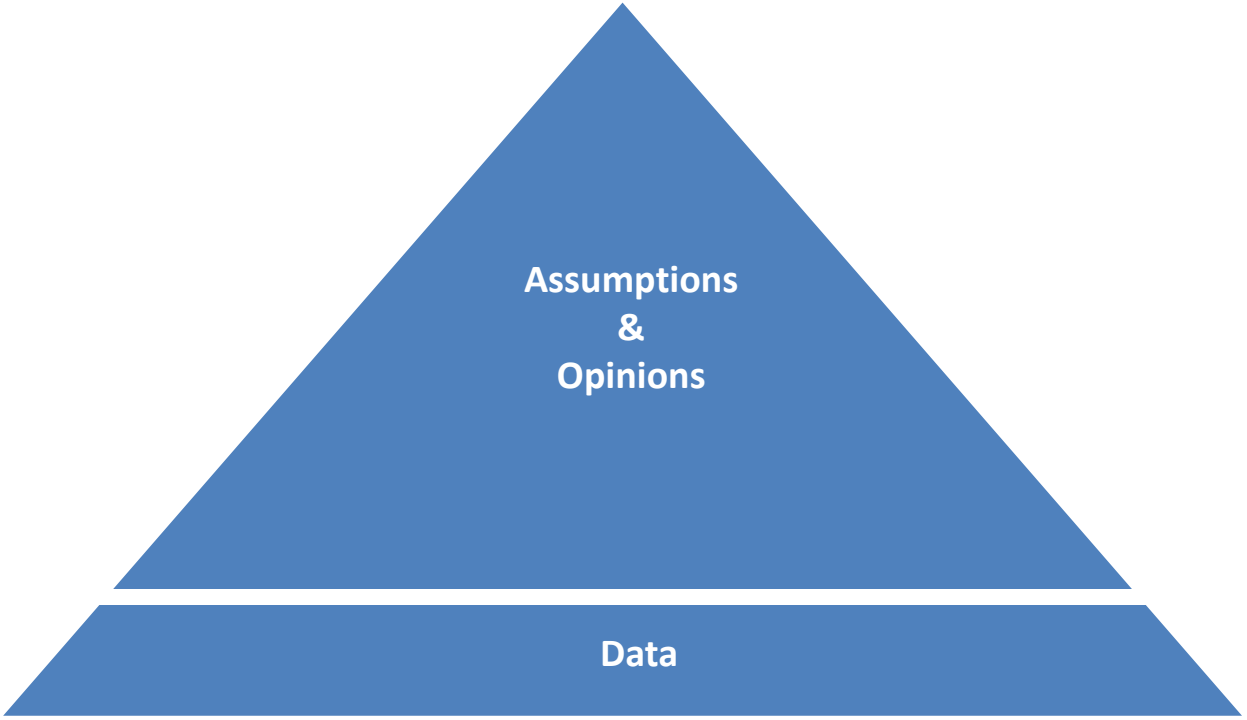
- Professional Geophysicist, with **32 years** of work experience. Chairman AF Academy & Managing Director, PARSAN, An engineering geophysics company
- **Gold Medalist**, University of Roorkee (Now IIT-Roorkee)
- Member of various working committees for development of Code of Practices and Standards, **including IRC**.
- **Pioneered use of Dam Geophysics in India in 1998.**
- Successfully used integrated geophysical approach for investigations across flowing rivers & for dam safety
- Completed geophysical investigations of **72 hydro power** projects.
- Extensive experience of Geophysical Investigations of Dams **(Concrete, Masonry & Earthen)**
- Geophysical investigation of Dams- **>80 dams**
- **Principal author of 'Guidelines on Geophysical Investigation of Dams'.**

Dam Investigations

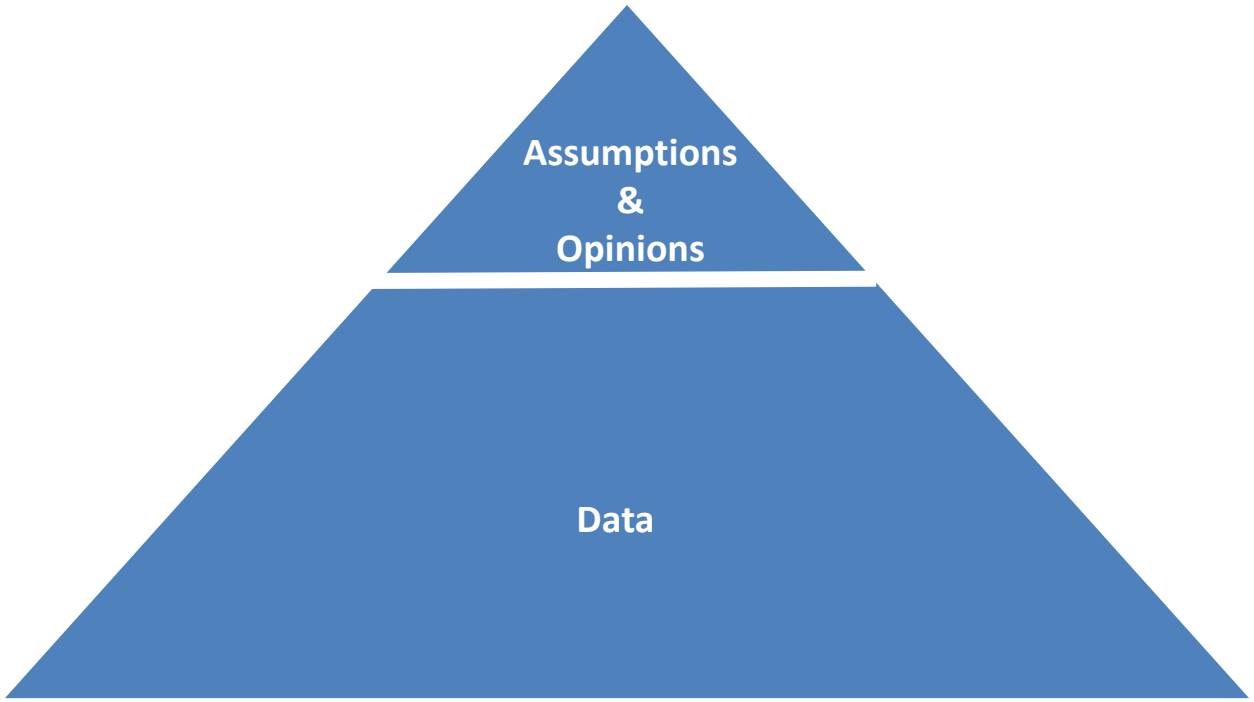
Present Scenario...

- Surface only
- Inspector Dependent
- Standards?

Traditional Approach?



Proposed Approach (Using Geophysics)?



Why Geophysics for Dams?

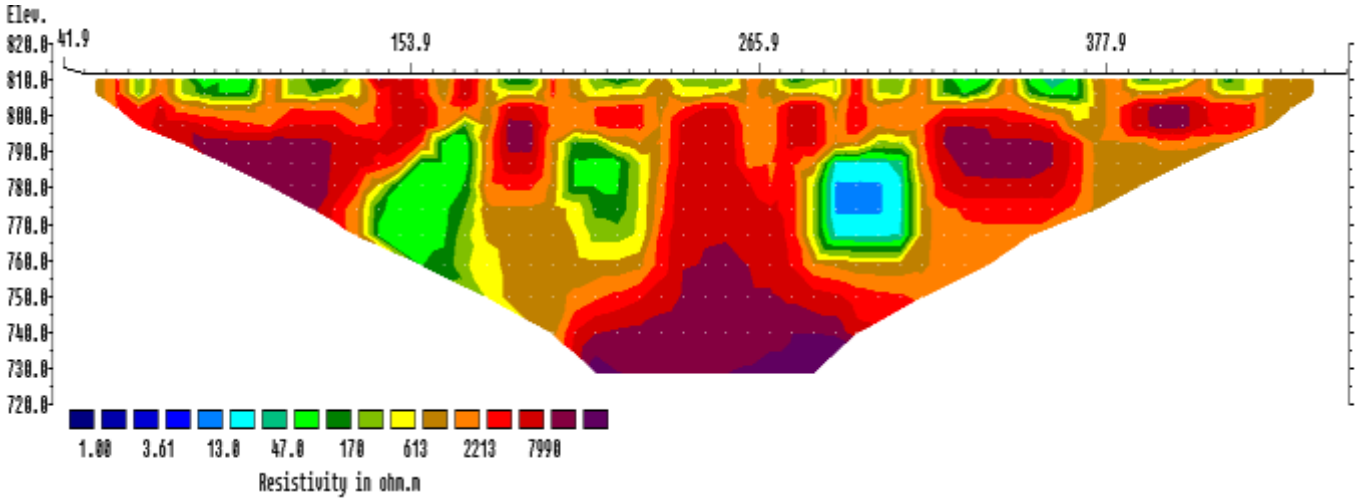
- Most suitable method for regular health checks of dams
- Early detection of problems
- Totally non-destructive, extremely suitable for structures like dams
- Helps design rehabilitation programs better and accurately
- Helps assess success of rehabilitation measures undertaken
- Identification of damaged areas inside the body dam
- Identification of not visible fractures and voids
- Identification of zones of seepages

⇨ More information + Low Cost + Quick

Available Solutions…

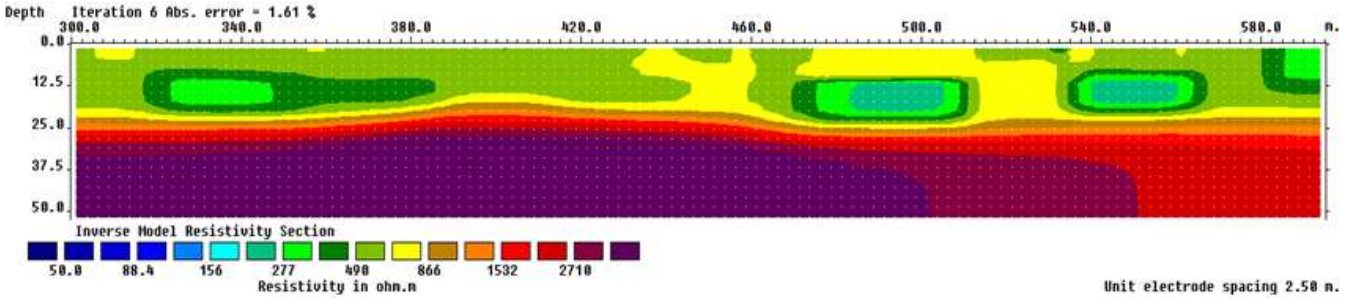
GEOPHYSICAL METHODS	ISSUES AND CONCERNS						
	CONCRETE DAM		EARTH EMBANKMENT DAMS			MASONRY DAMS	
	CRACKS	DEGRADATION	WATER LEAKS	LANDSLIDE	SINK HOLES	WATER LEAKS	STRENGTH
Electrical Resistivity			■	■		■	
Streaming Potential			■	■		■	
Georadar	■	■	■	■	■	■	
Radar Tomography	■	■	■		■	■	
Seismic Tomography	■	■	■		■		■
Seismic Refraction			■			■	■
ReMi		■		■			■

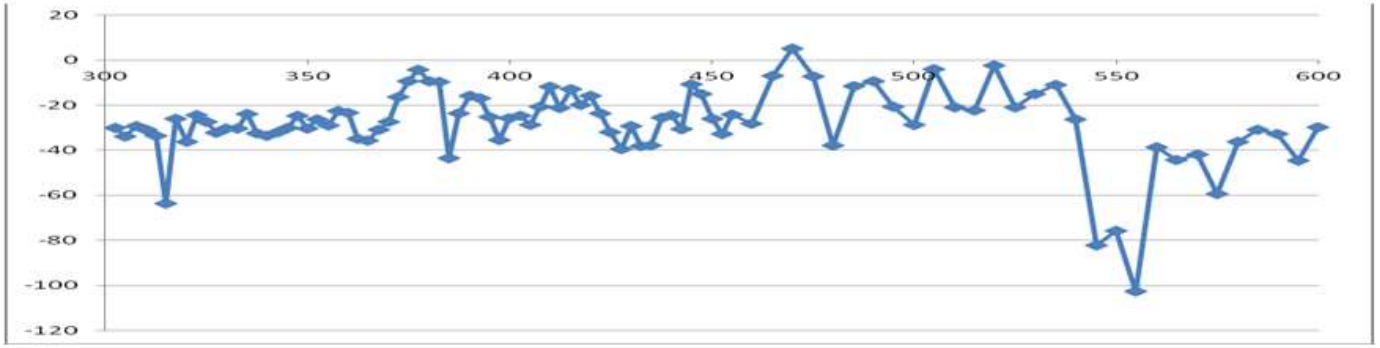
Electrical Resistivity Imaging Results...



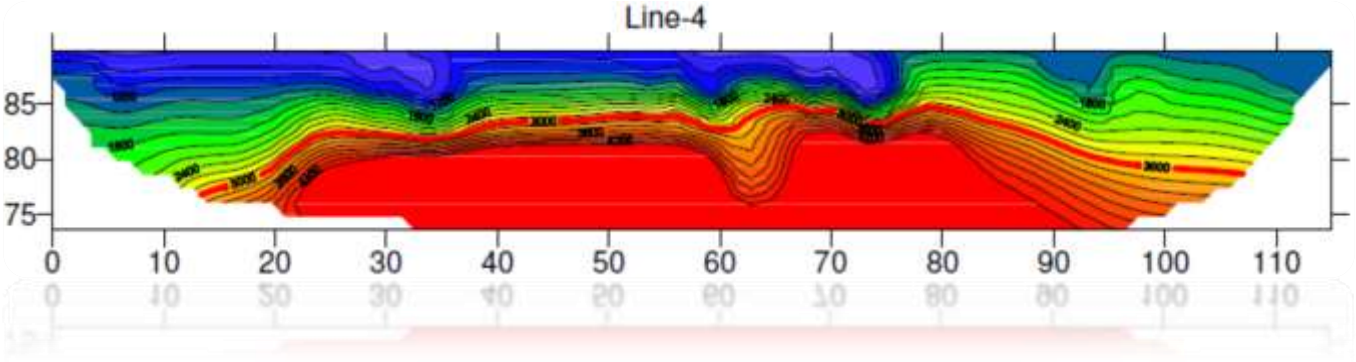
Electrical Resistivity Section from dam crest of a masonry dam Showing Zone of Saturation (Green & Blue)

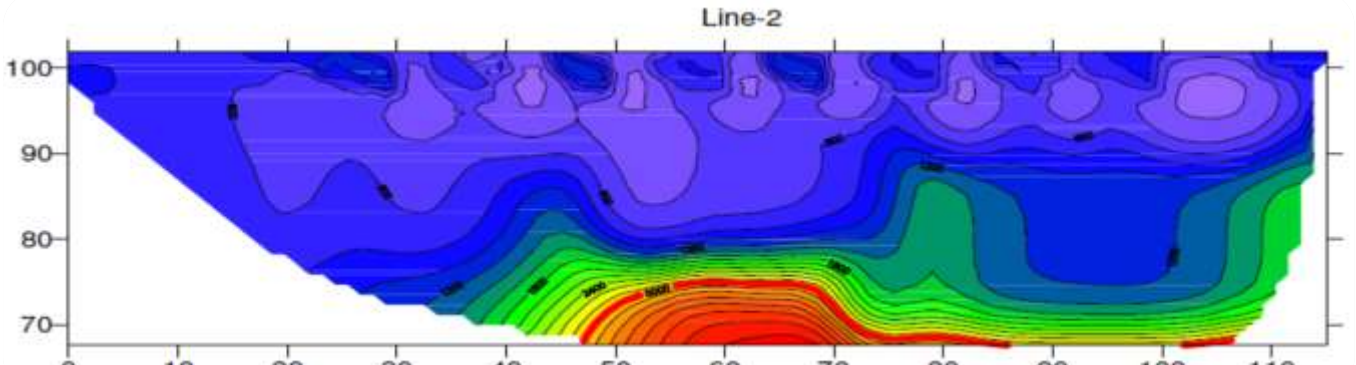
SP Results (with ERI)…



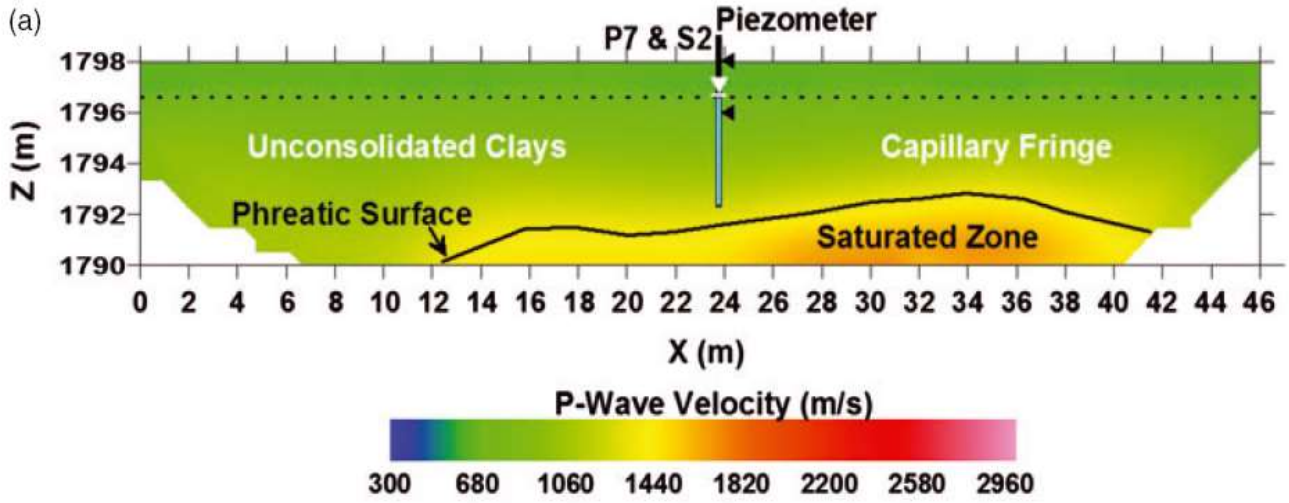


Seismic Refraction- Dam Body ‘P’ Wave Velocity Model…

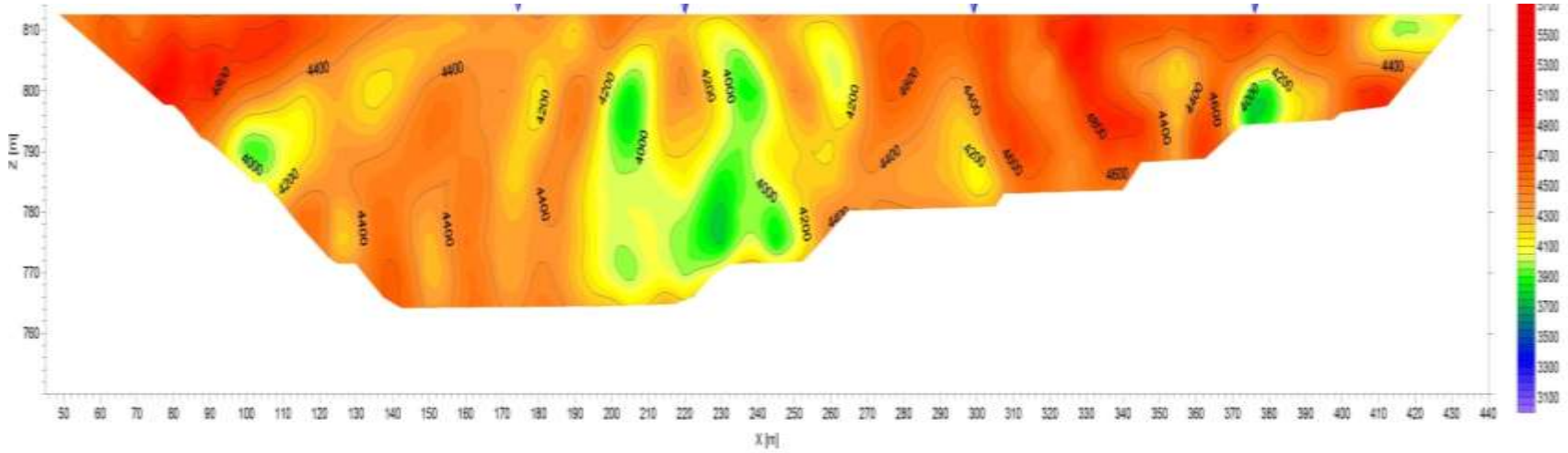




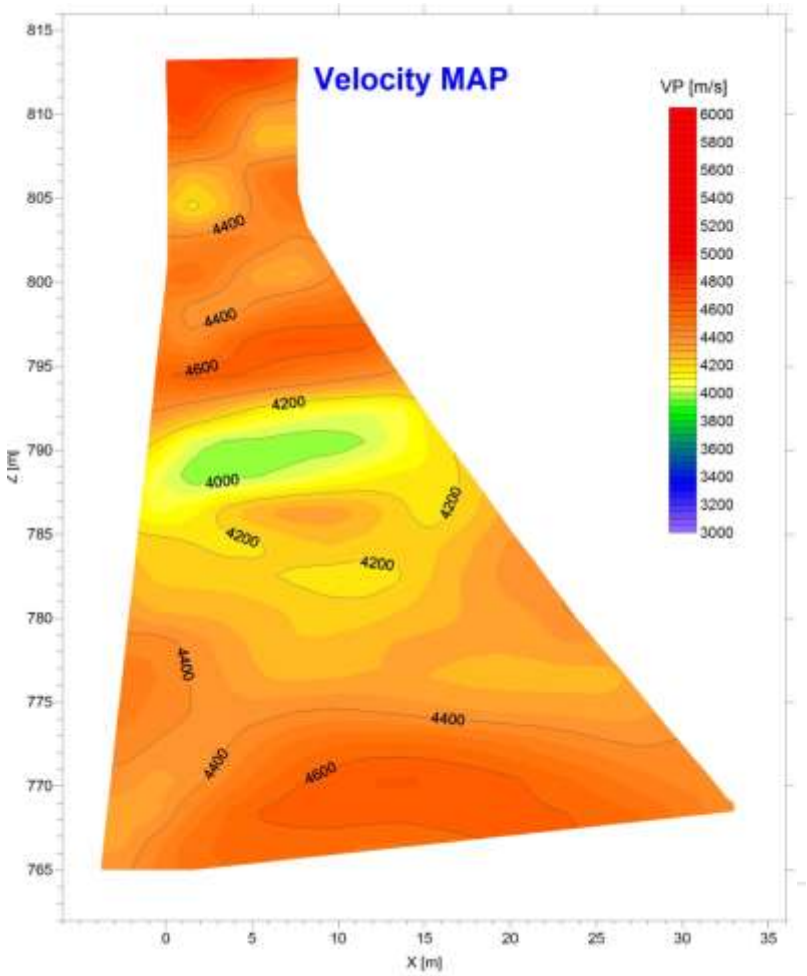
Seismic Refraction- Phreatic Surface…



L-Section Tomography…Inversion & Velocity Model

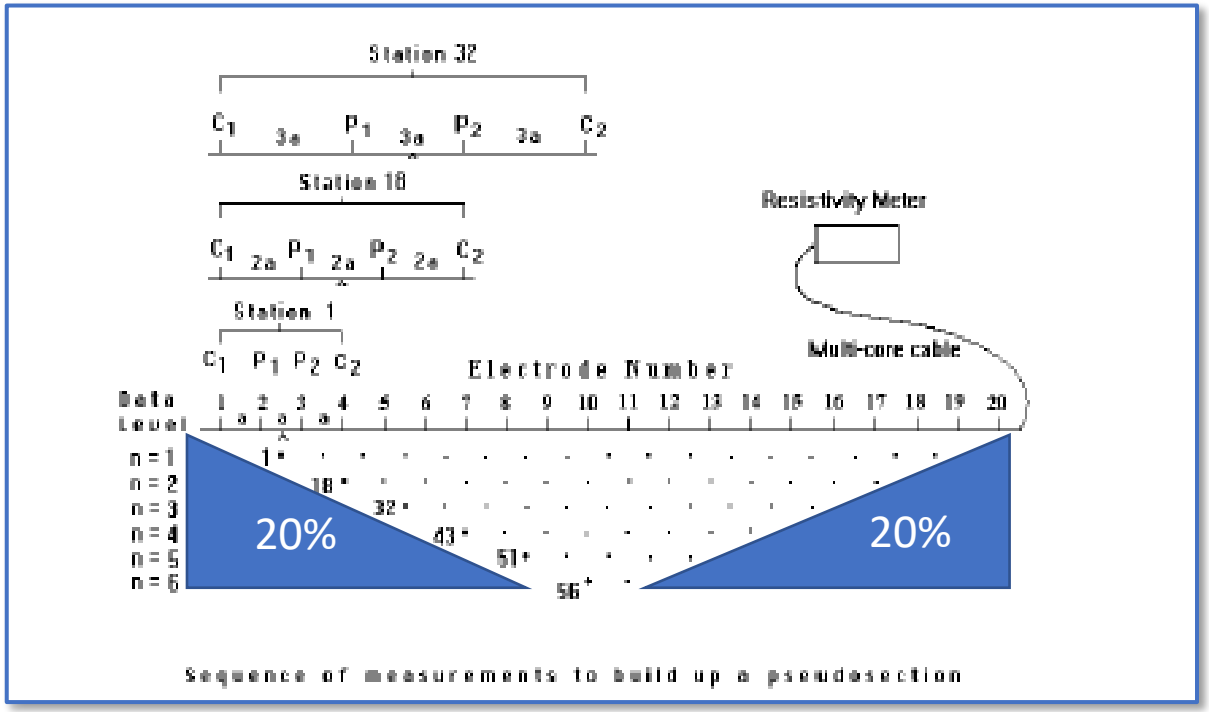


Cross Face Tomography… Inversion & Velocity Model




keep improving

Presenting MERIT- An improvement over traditional ERI

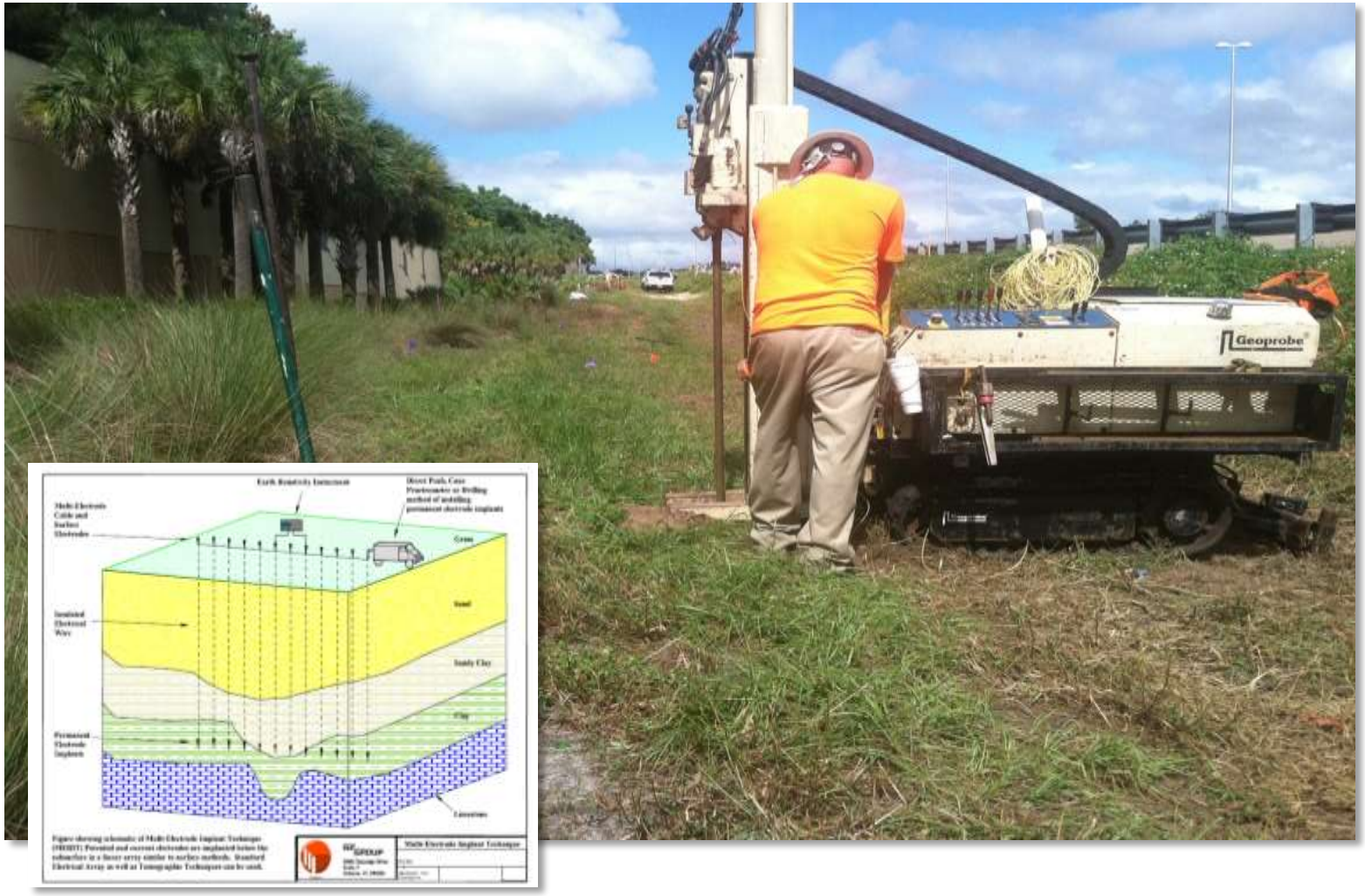


Upper 1/3 Data Level = 55% Data

Middle 1/3 Data Level = 33% Data

Lower 1/3 Data Level = 12 % Data

A Departure from the Standard Surface ERI



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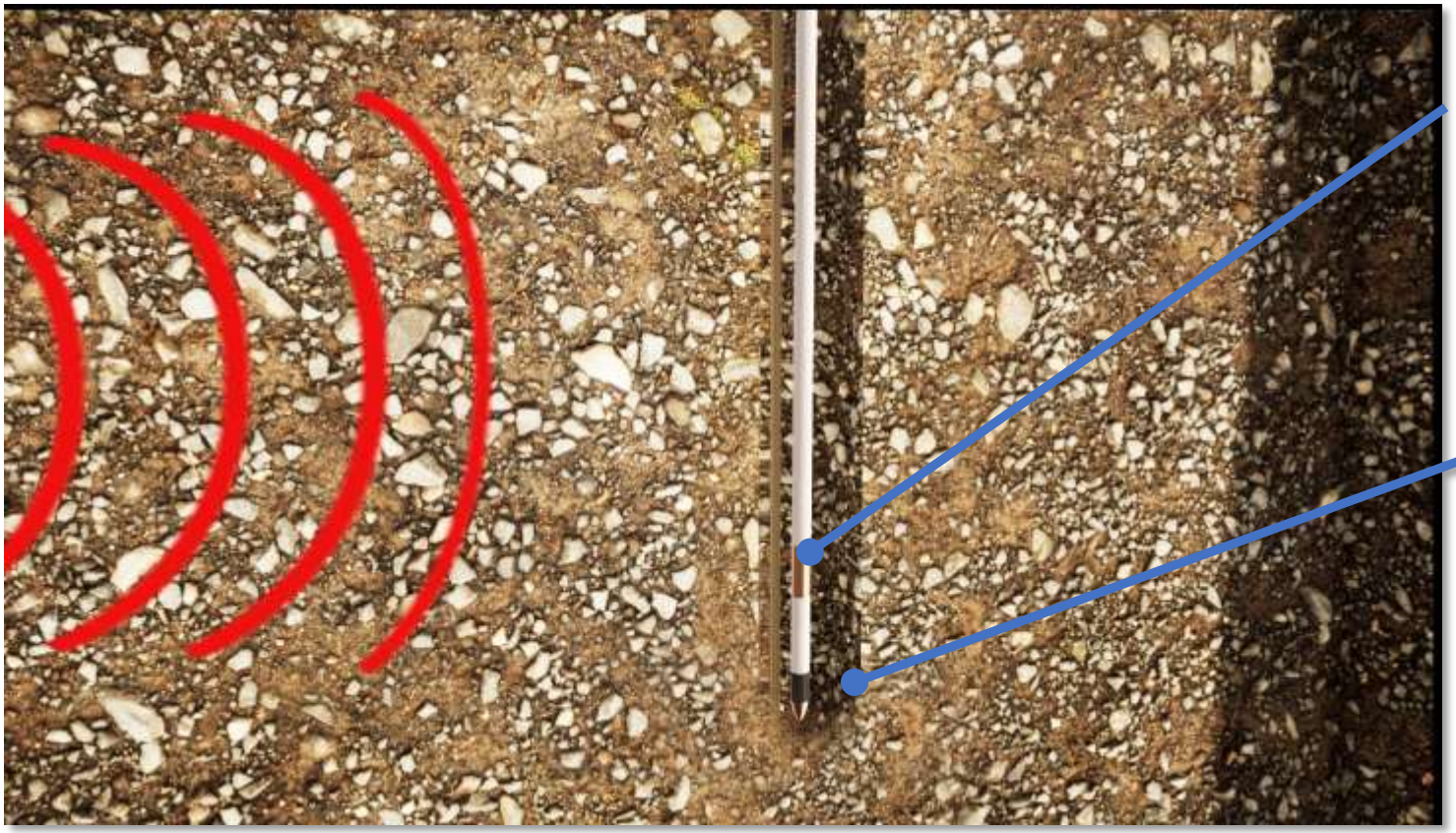
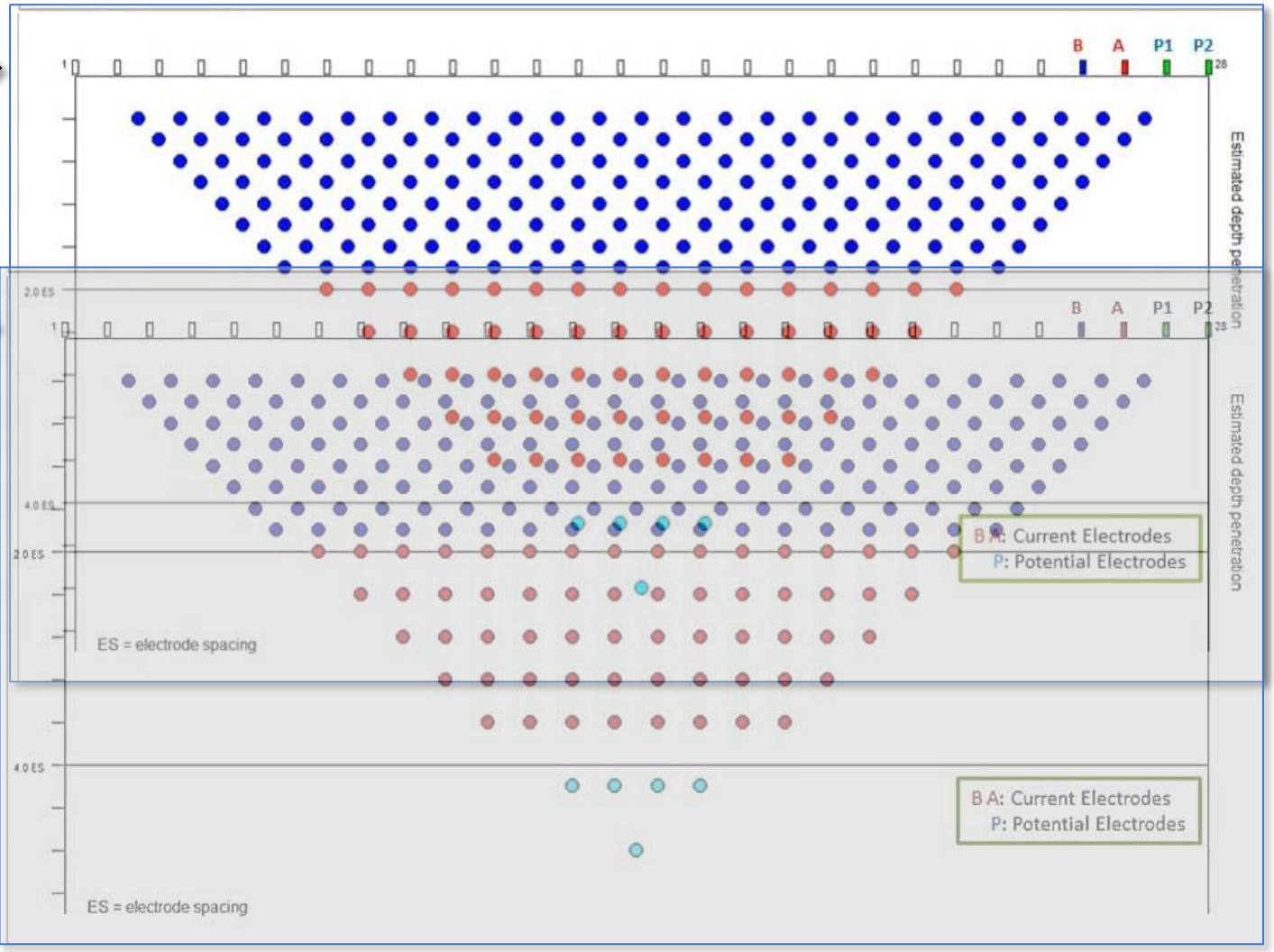


Implants Only 2cm Diameter

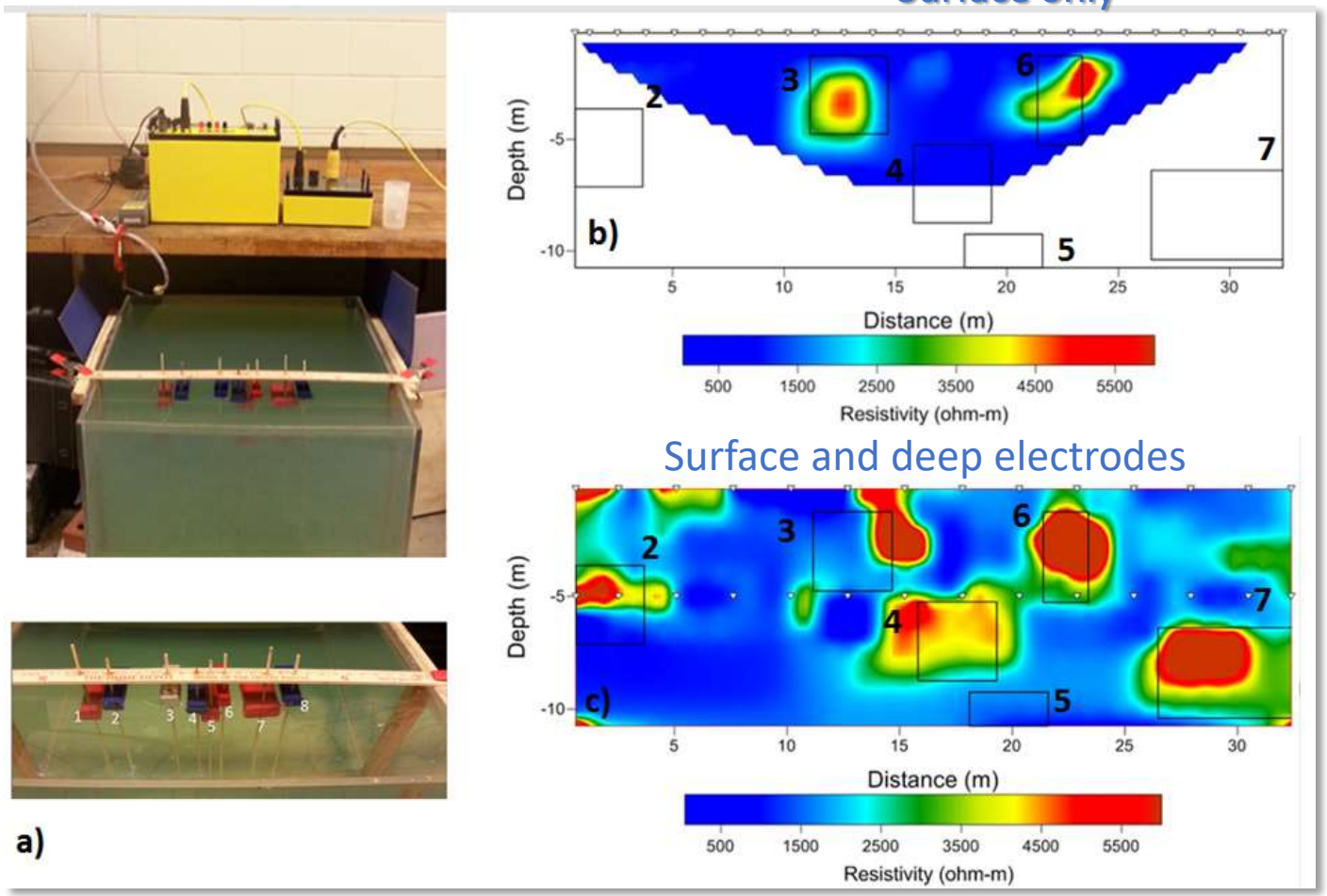
A Tomographic Method Using Implants

Surface Electrodes

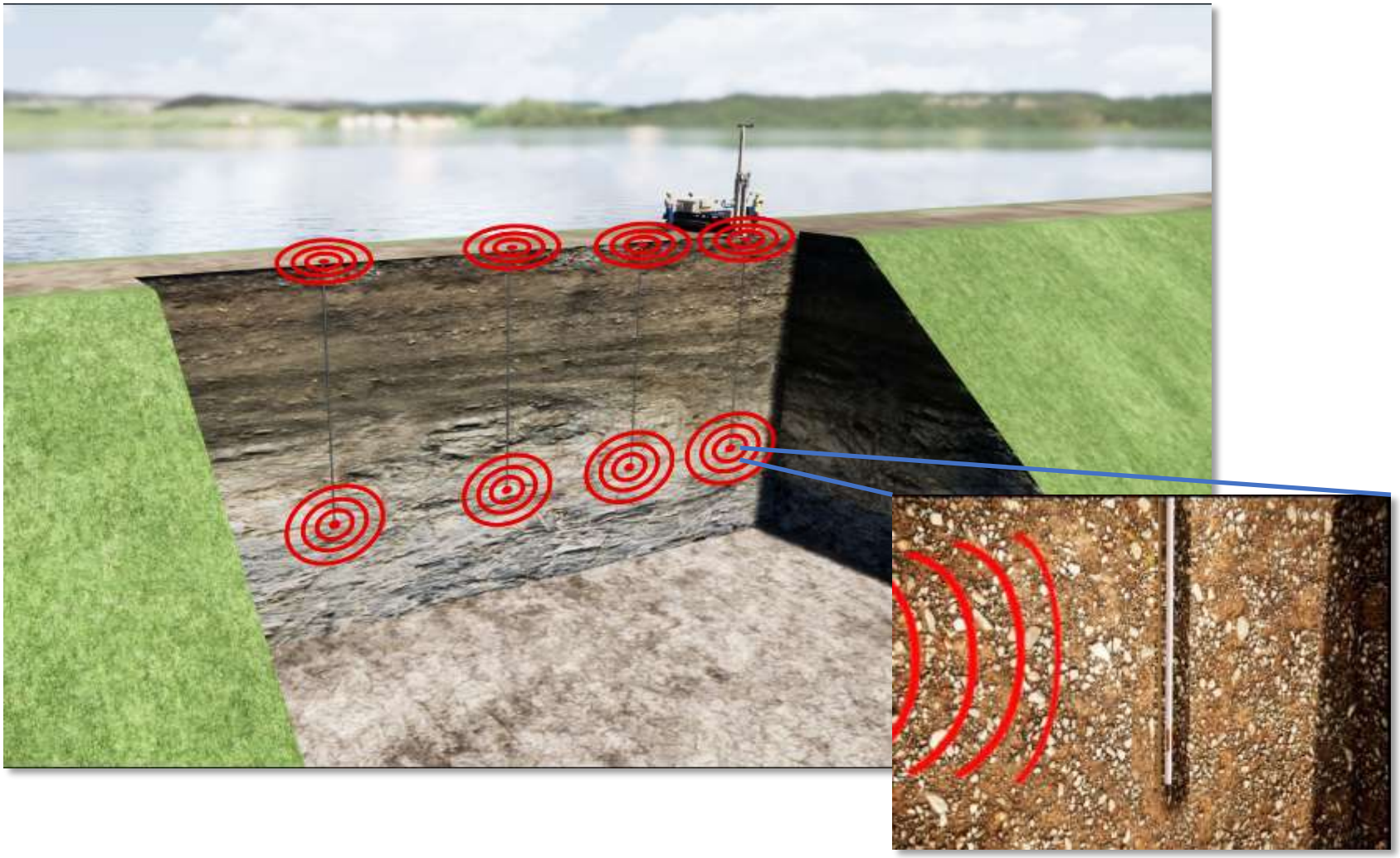
Implanted Electrodes



Lab experiments – 3D blocks



Application for Dams



Application for Dams

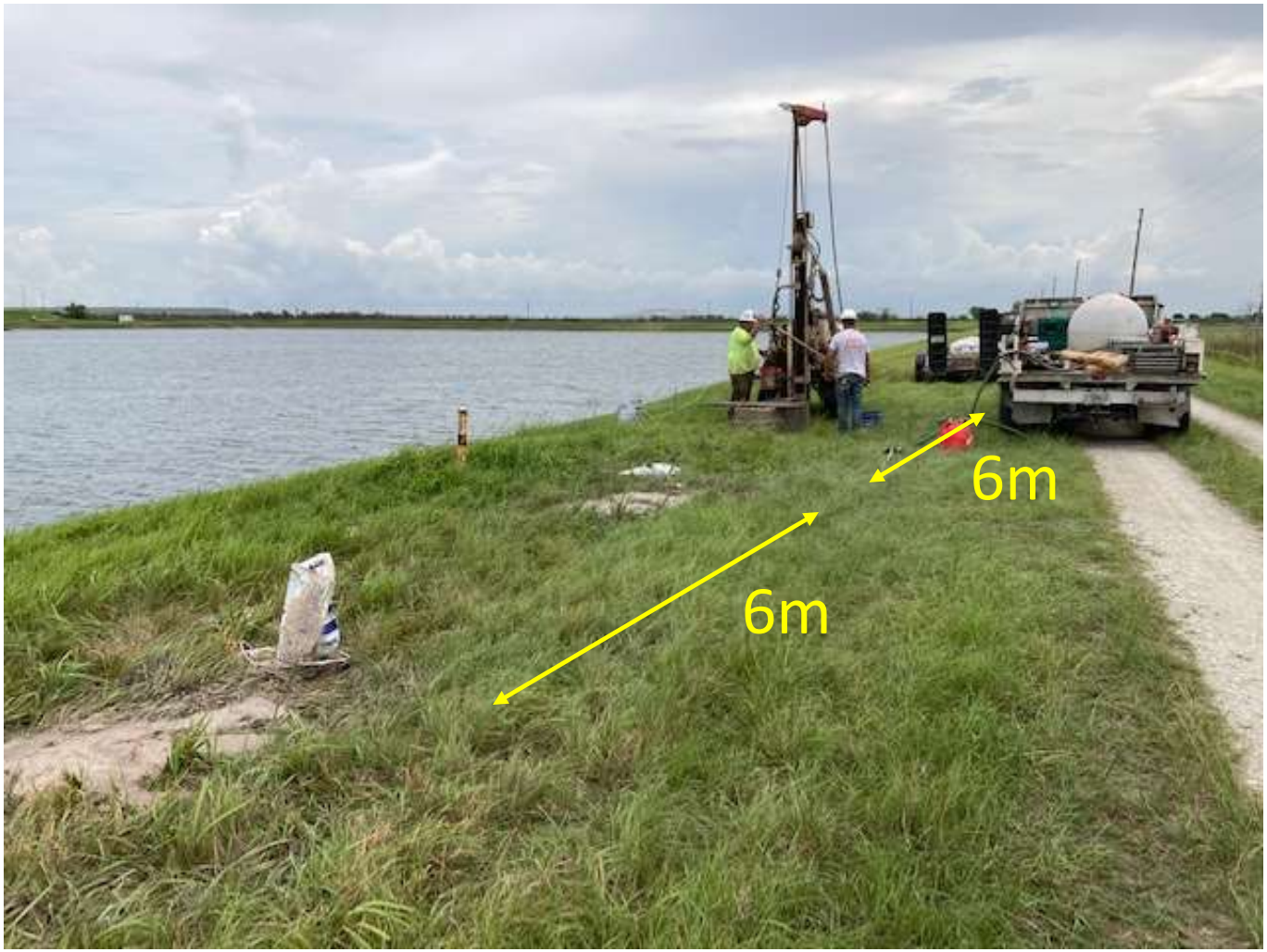
- The MERIT system for dams is a concept based on small low-cost multi functional implants placed within a dam along the axis of the core at few meter spacing (6m typically) that can provide near medical quality imaging of the core, foundation and into the bedrock due to the high density of data collected.

- When MERIT is combined with SP and Temperature measurement, capability the MERIT system can be used for **long term monitoring of the core** for potential failures modes that involve seepage and sinkholes.

MERIT Case Study
Deep Karst Mine Tailing Dam /Cooling Pond

Piezometers in earthen dam in central Florida indicated large volume of water was being lost, Geophysical Investigation using MERIT was chosen because of the depth sinkhole development in the region. Three 1000 foot MERIT surveys identified sinkhole throats at 100 feet deep and sinkhole continues to 250 feet deep.

Location of MERIT Surveys



Installation of MERIT implants via standard mud rotary drilling method near P-13, note the spacing of 6m, 56 implants were installed for each of the three MERIT lines

Installation of Implants

View of the implant attached to the drill string

Geophysical Measurements

Geophysical lines measured 1,100 feet each and consisting of data collection locations on the surface and at depth for each line. The geophysical survey encompassed total over 3,000 measurements per line

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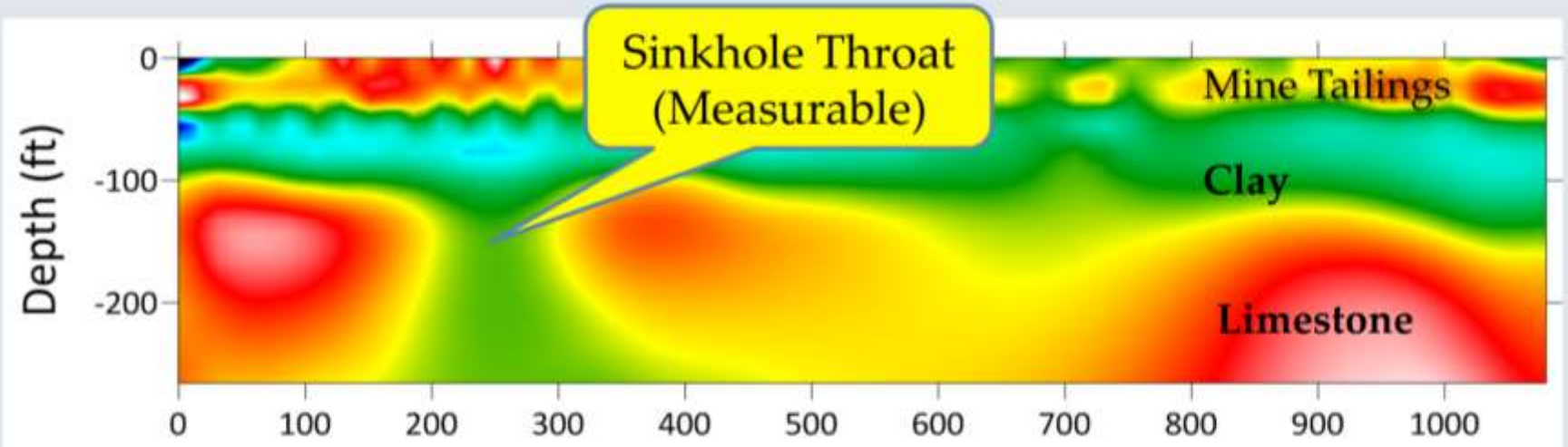
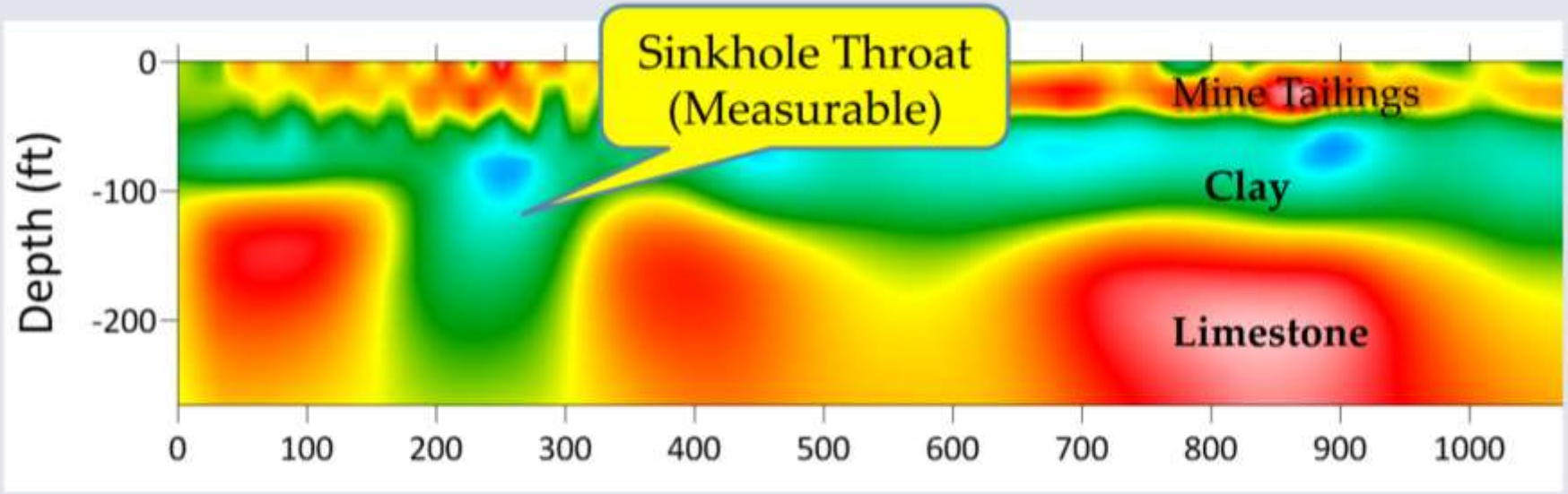
Geophysical Results



Geophysical Results



Conclusions
Applications of Geophysics & MERIT

- Geophysical methods are most suitable method for regular health checks of dams, enabling early detection of problems

- Helps design rehabilitation programs better and accurately and helps assess success of rehabilitation measures undertaken

- MERIT represents state-of-the-art to dam safety with the application of low-cost sensors that can provide detail view of the critical elements of entire core of a dam. With the long-term 24/7 monitoring capability of the inside of a dam and highest resolution obtainable for electrical resistivity, this unique technology represents a significant improvement to dam safety

Thanks for your attention

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