



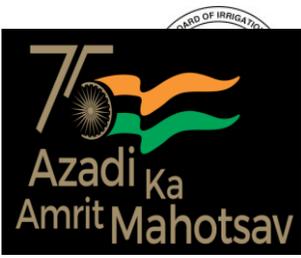
**CLIMATE-RESILIENT DAMS AND
HYDROPOWER INFRASTRUCTURE
INTEGRATING
ENVIRONMENTAL SUSTAINABILITY
IN PLANNING AND DEVELOPMENT**

**Health Assessment of Dams by
Geophysical Techniques**

Dr. Sanjay Rana, PARSAN, India



About PARSAN



- Only company in India providing complete dam geophysical solutions (>120 dams investigated)
- Highly experienced and trained staff.
- Offices in Delhi, Bhopal, Kolkata, Bahrain, Saudi Arabia and Singapore. An Indian Multinational
- Work experience in India, Nepal, Bhutan, Bangladesh, Singapore, Oman, Afghanistan, Saudi Arabia, Bahrain, Kuwait.....





Why AI & Geospatial Technologies Matter for Climate-Resilient Dams?



- **From Reactive Safety to Predictive Resilience**

- Climate change is increasing **hydro-climatic extremes**: intense rainfall, rapid reservoir fluctuations, extreme drawdown–refill cycles, and seismic-hydrological coupling
- These stresses accelerate **seepage evolution, internal erosion, material degradation, and foundation distress**
- Conventional visual inspections and isolated instrumentation are **no longer sufficient**
- **Geospatial and geophysical datasets** provide *continuous, volumetric, non-destructive insight* into dam health

- **Artificial Intelligence enables:**

- Pattern recognition in large, multi-temporal geophysical datasets
- Early detection of subtle anomalies before visible distress
- Objective, data-driven decision support for dam owners and regulators

**Climate-resilient dams
require moving from
episodic inspection to
AI-assisted,
geospatially integrated
monitoring.**



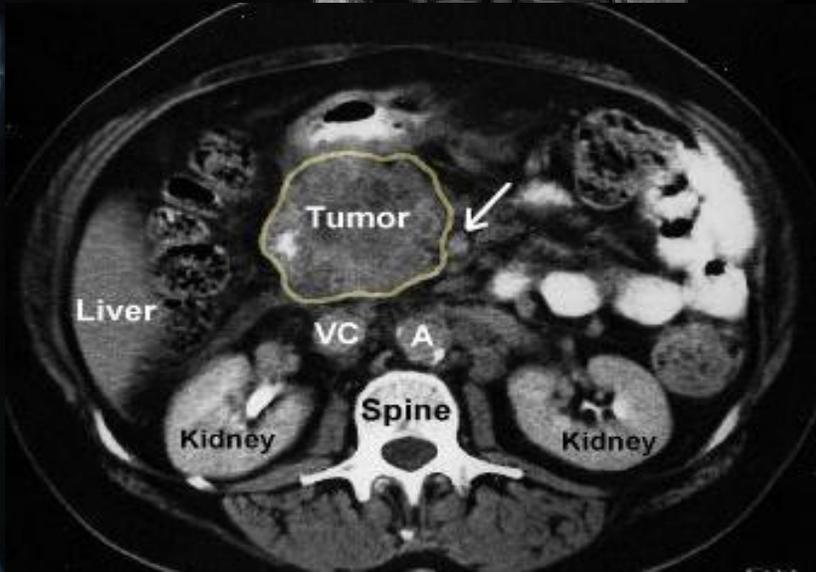
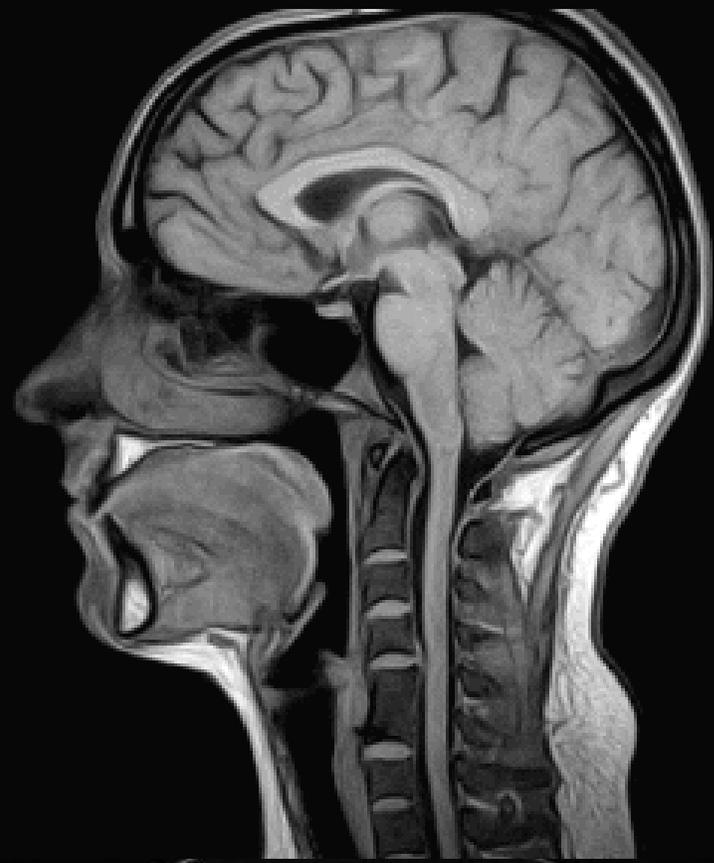
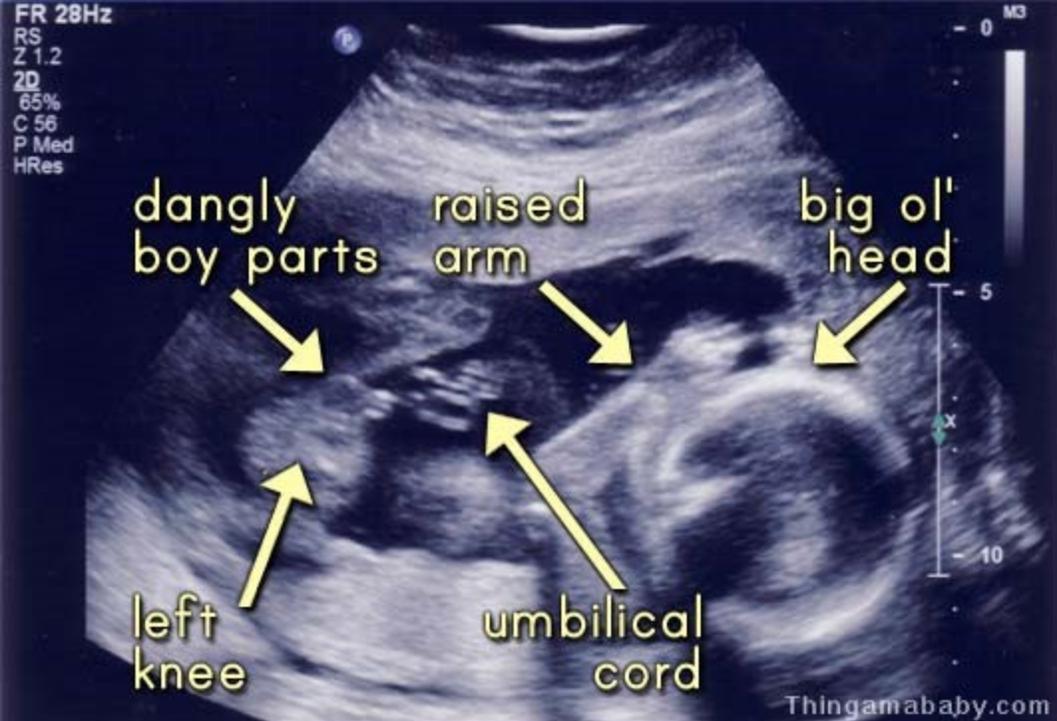
Why AI & Geospatial Technologies Matter for Climate-Resilient Dams?

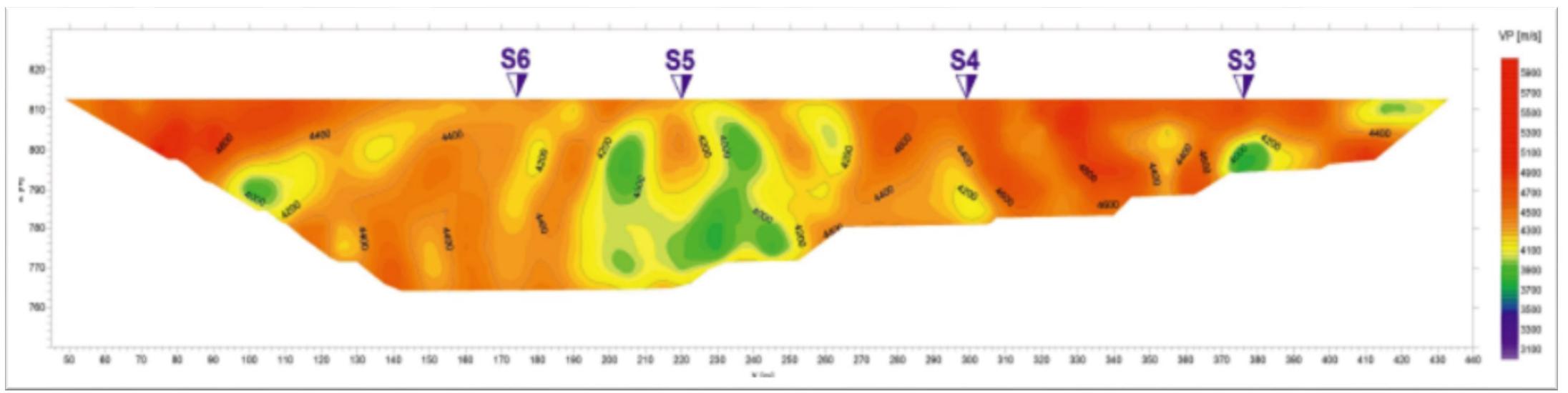
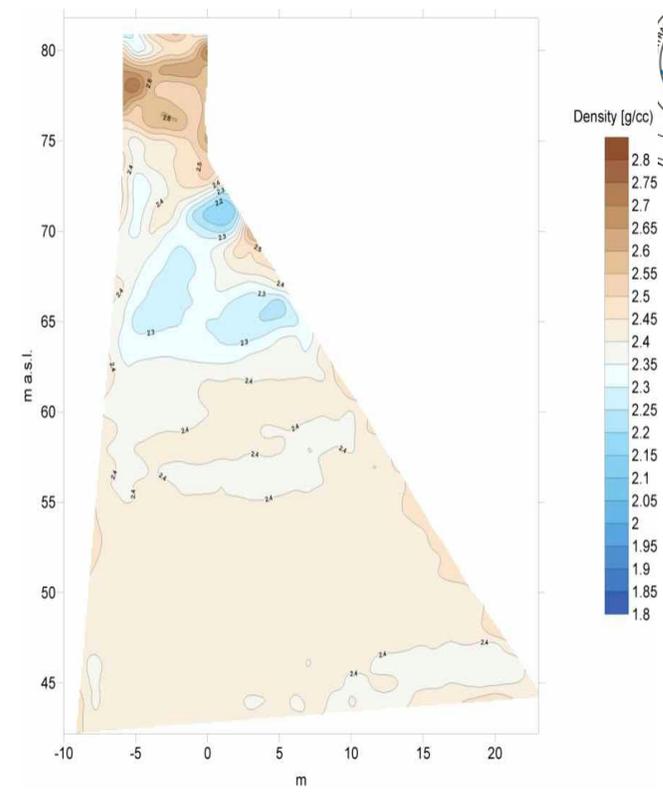
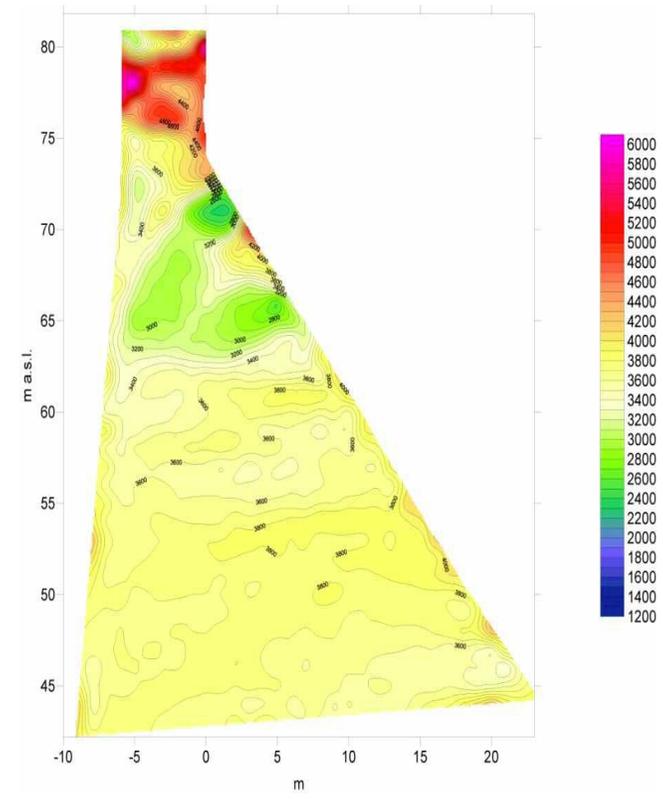
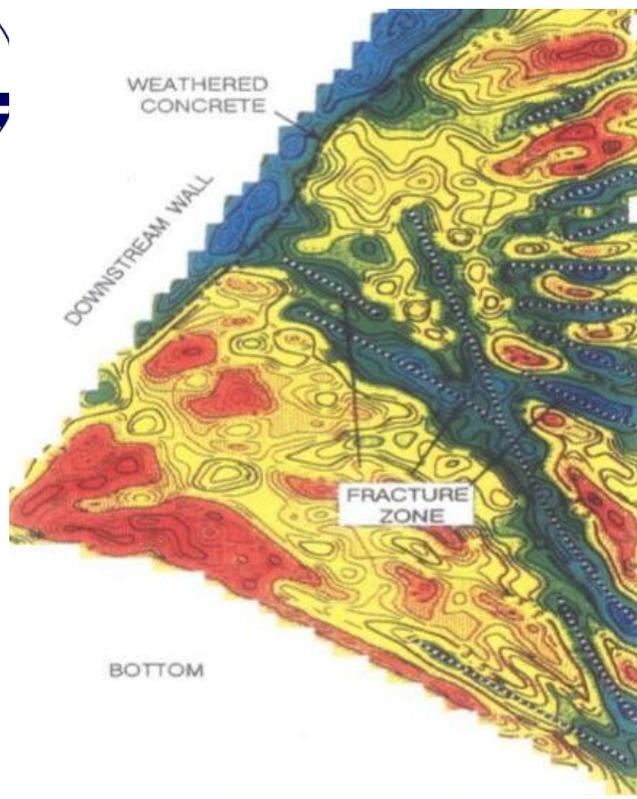


Geophysics, when combined with AI and geospatial intelligence, can become the backbone of climate-resilient dam and hydropower systems, not just for inspection, but for informed planning and sustainable decision-making..



Geophysical Investigations.....





Which Technique/ Tool?

- **Define objective:** Seepage/ Leakage, Subsidence, Strength, Residual Density, etc.
- Consider **depth of Investigation** required
- Consider **dam height to length ratio** & Geometry of Dam
- **Remember:** Wrong choice of tool can result in failure of geophysical program

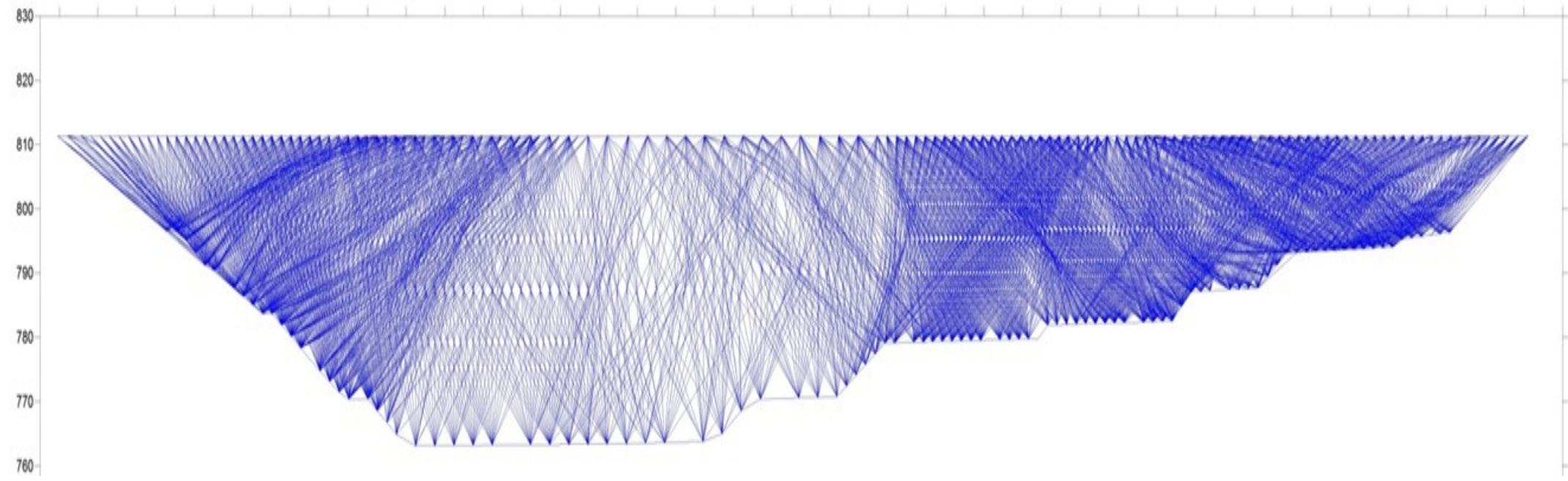


Which Technique/ Tool?

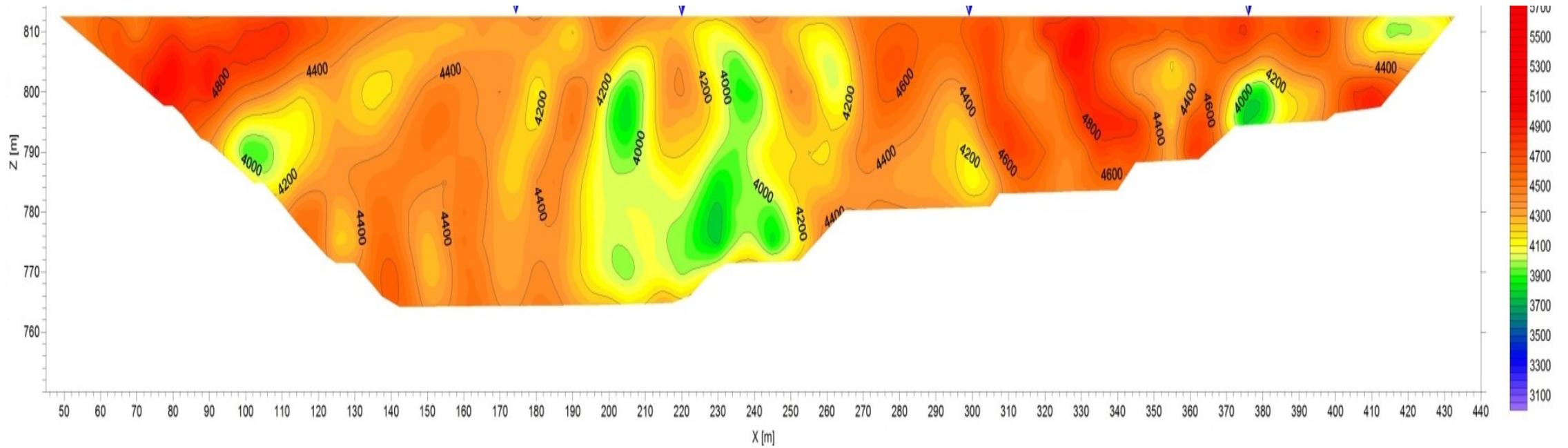
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Streaming Potential	Red	Red	Green	Red	Green	Green	Red	Red	Red	Green	Green
Seismic Tomography	Yellow	Green (with blue circle)	Green	Green	Yellow	Red	Green	Green	Red	Red	Green
Seismic Refraction	Red	Red	Red	Yellow	Red	Red	Green	Green	Red	Red	Green
GPR	Green	Yellow	Yellow	Red	Red	Red	Green	Green	Green	Yellow	Yellow
MASW & ReMi	Red	Yellow	Red	Yellow	Red	Red	Green	Green	Red	Green	Green

■ Most Suitable
 ■ Moderately Suitable
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L-Section Tomography...Ray Path Coverage

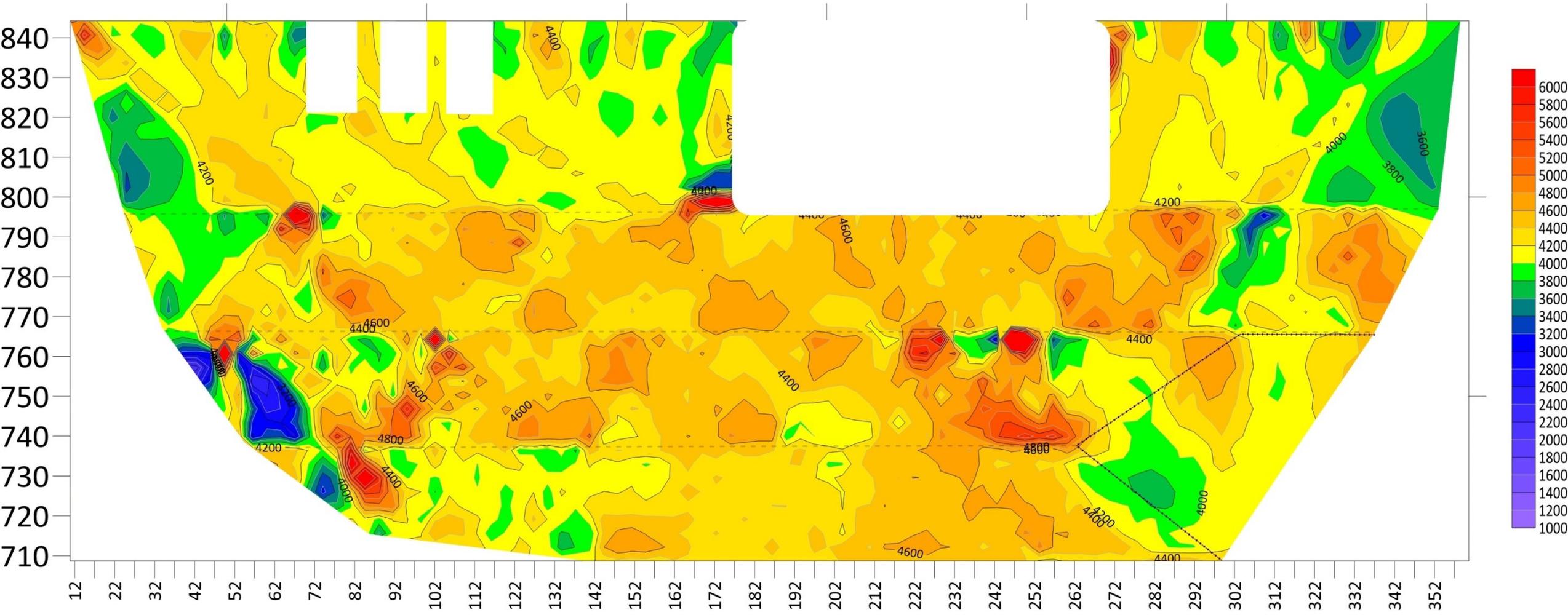


L-Section Tomography...Inversion & Velocity Model



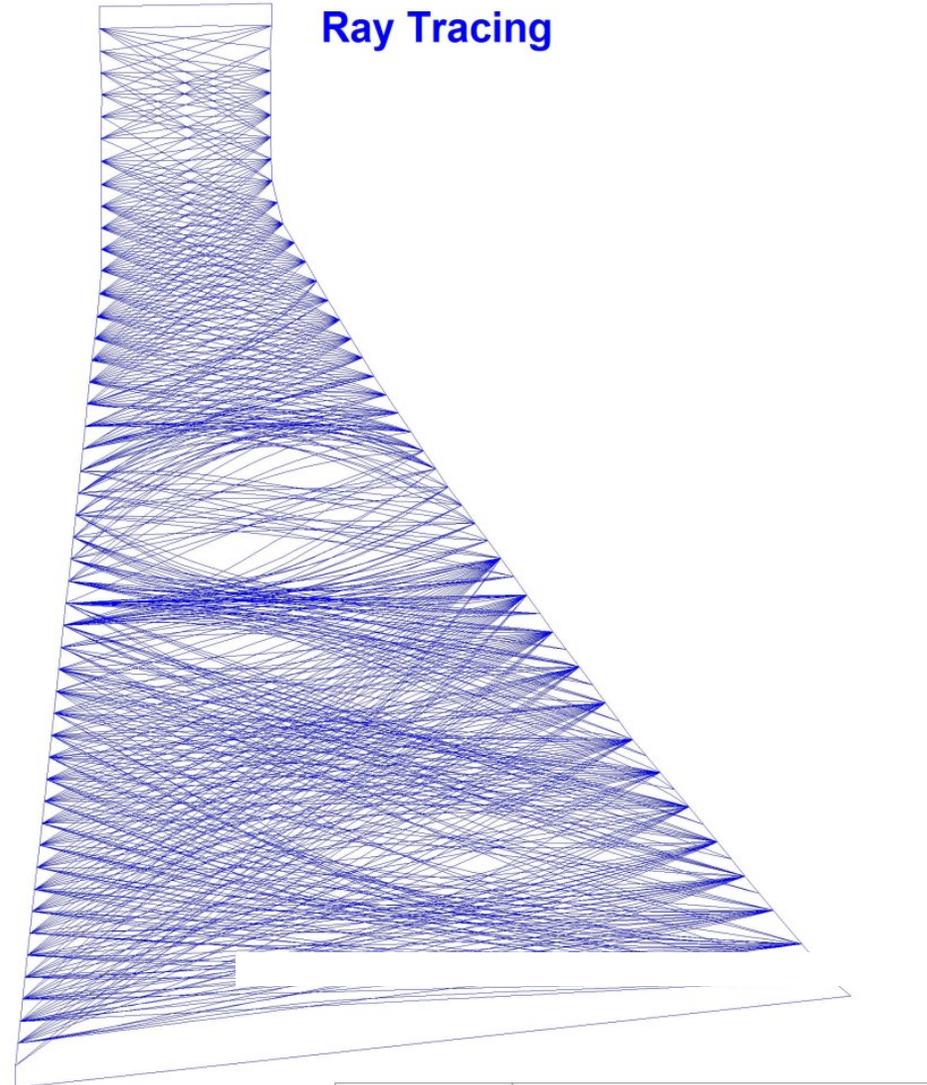


L-Section Tomography...Multiple Galleries

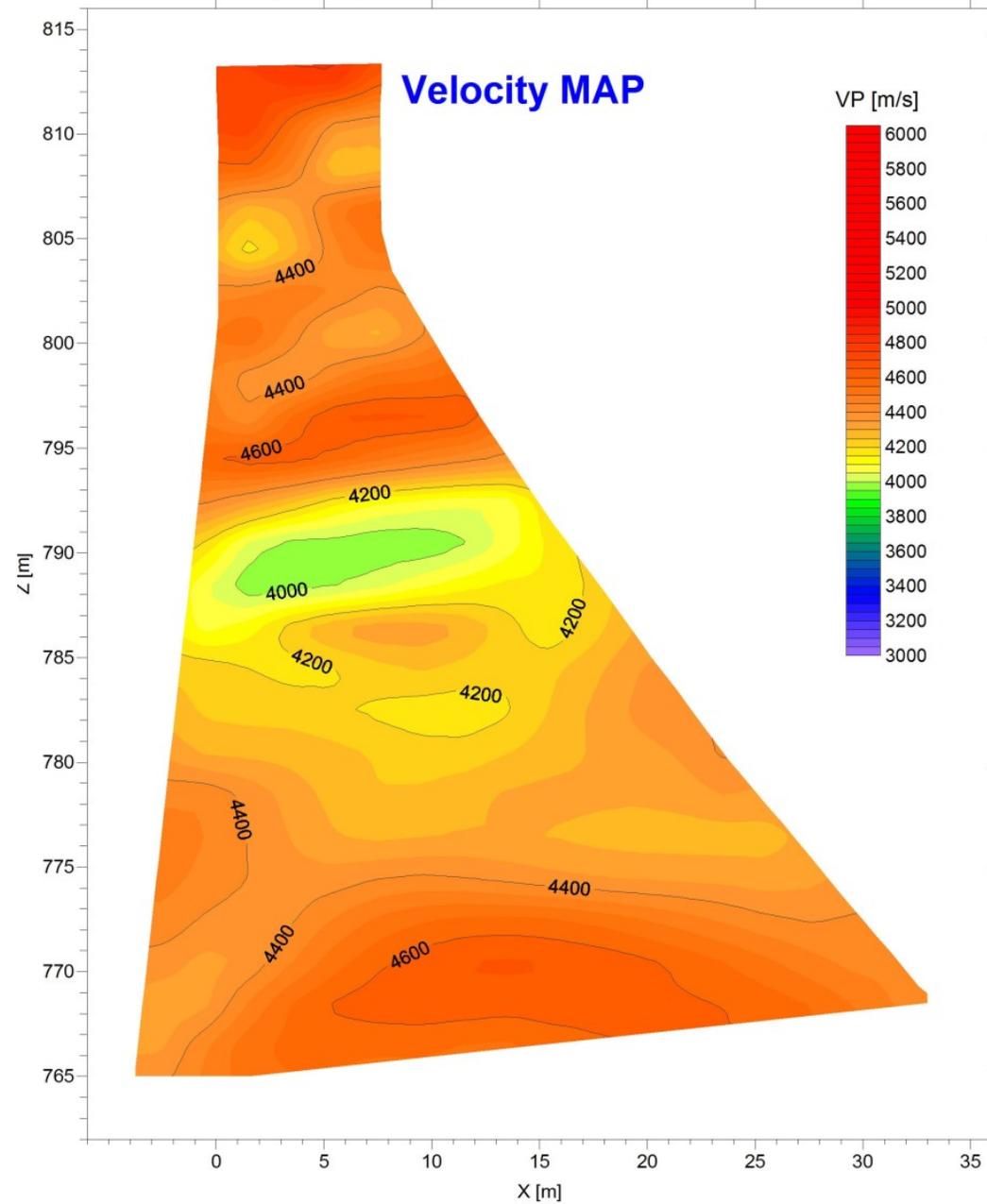




Cross Face Tomography... Ray Coverage

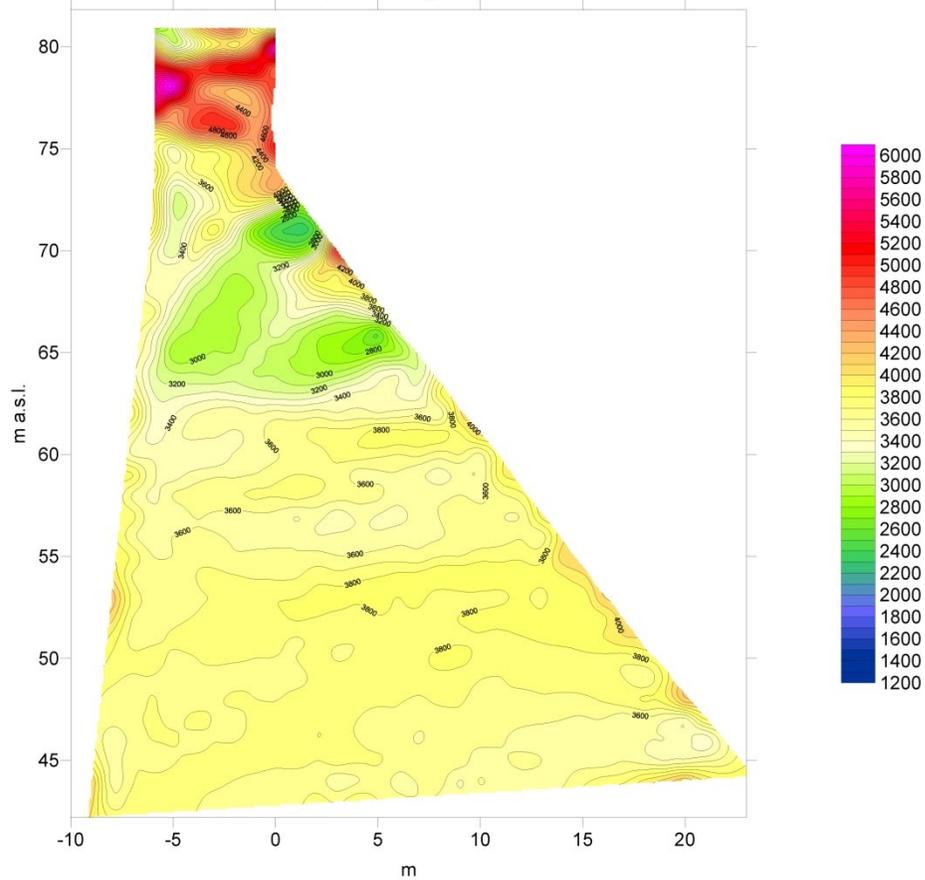


Cross Face Tomography... Inversion & Velocity Model

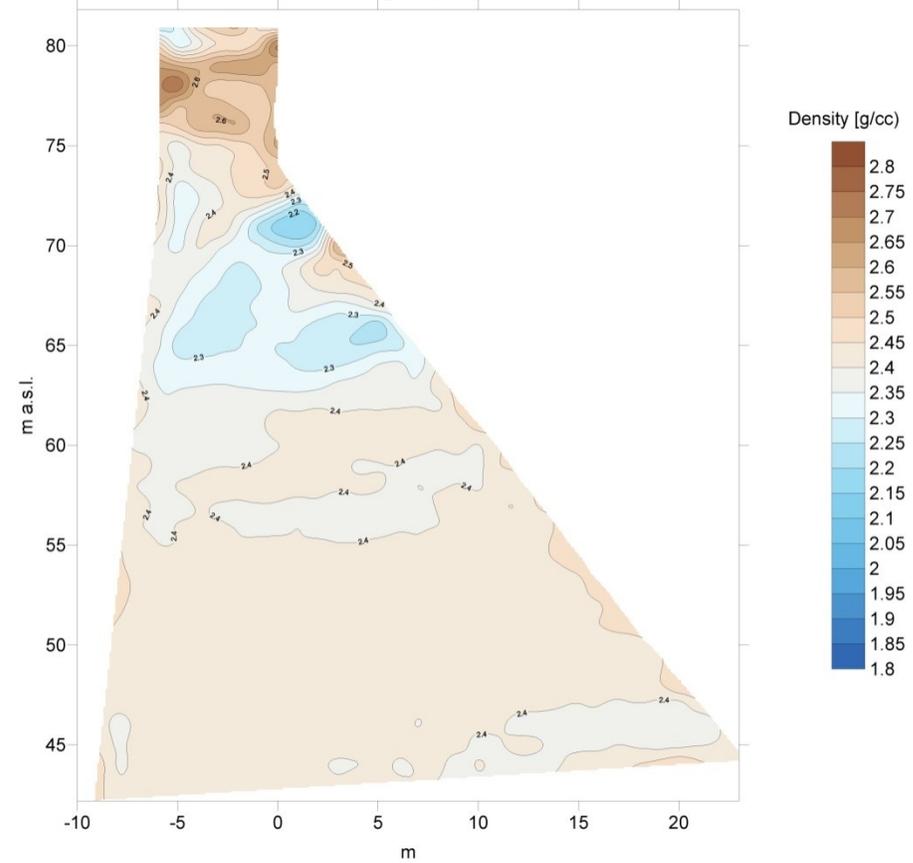


Cross Face Tomography... Results

Velocity tomography



Density tomography



Which Technique/ Tool?

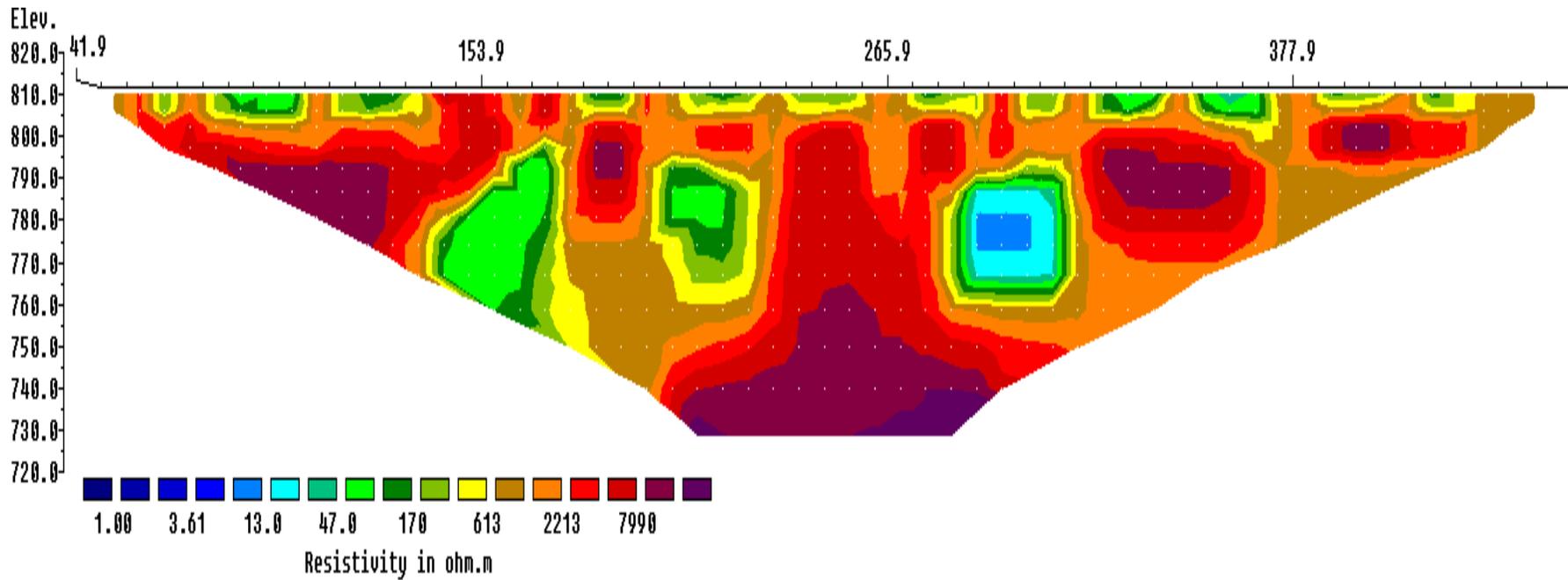
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MASW & ReMi	Red	Yellow	Red	Yellow	Red	Red	Green	Green	Red	Green	Green

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ERI- Typical Line Layout on Dam...



Electrical Resistivity Imaging Results...



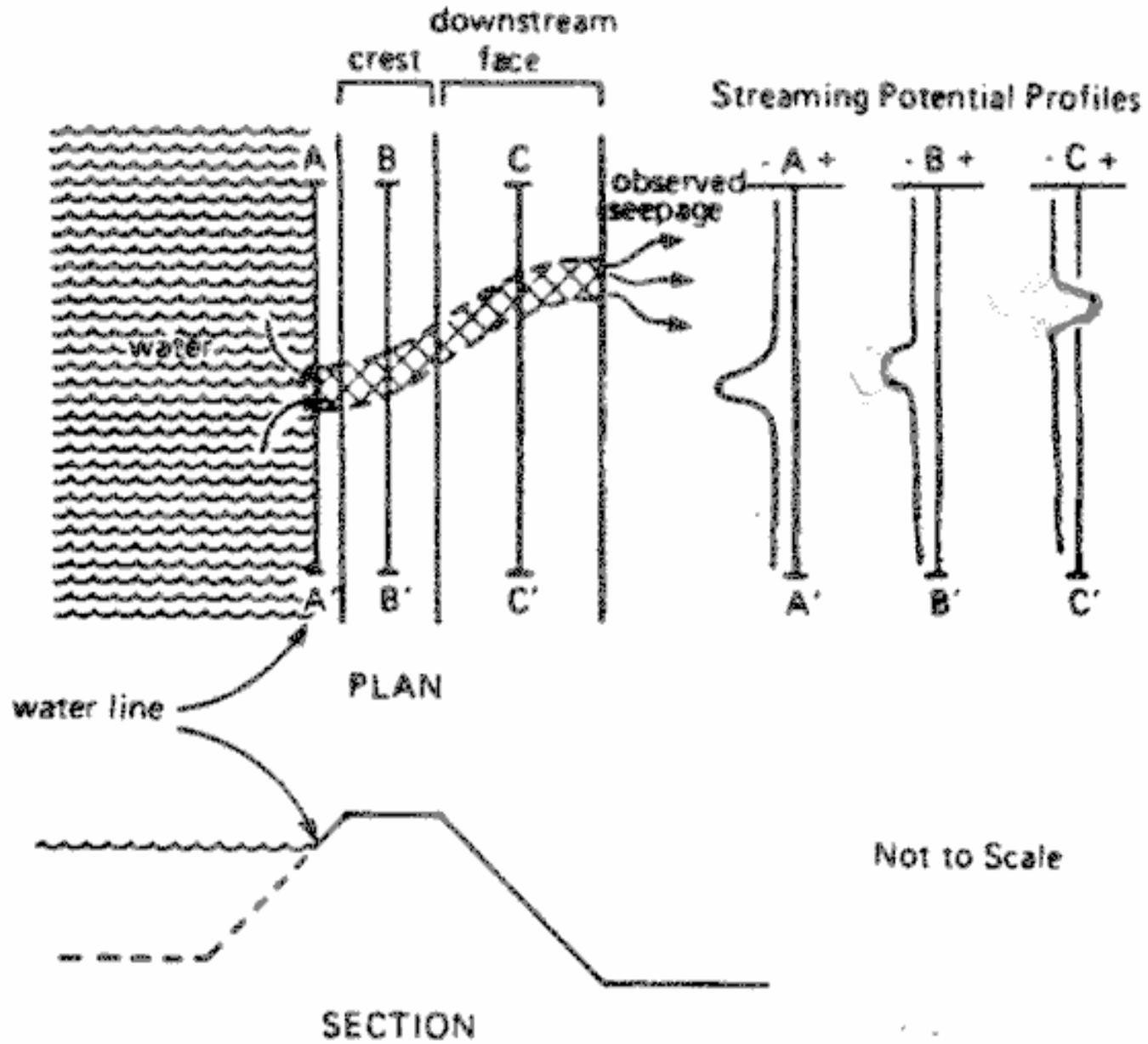
Electrical Resistivity Section from dam crest of a masonry dam Showing Zone of Saturation (Green & Blue)

Which Technique/ Tool?

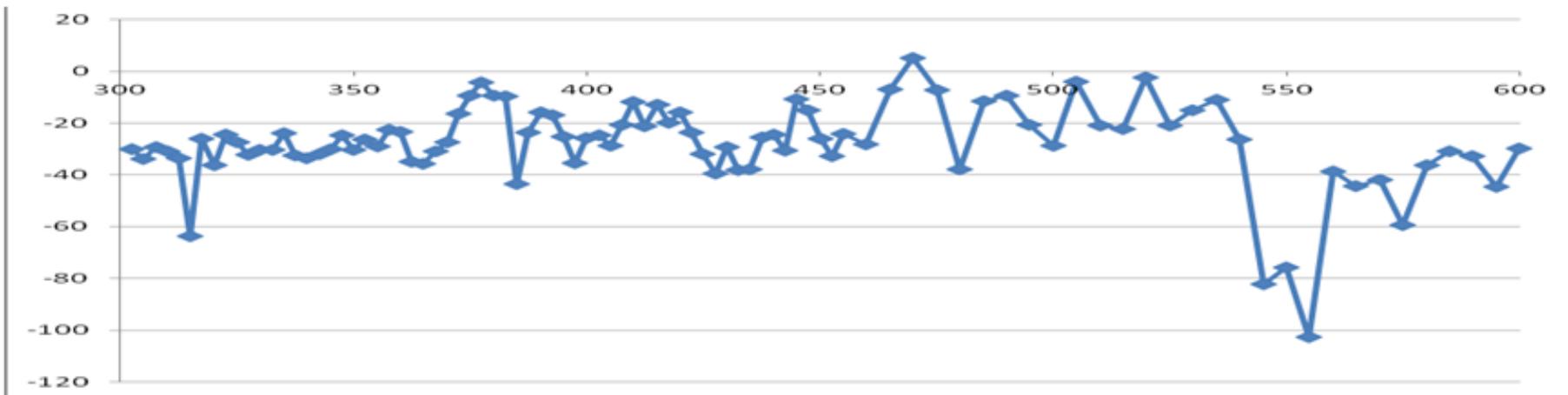
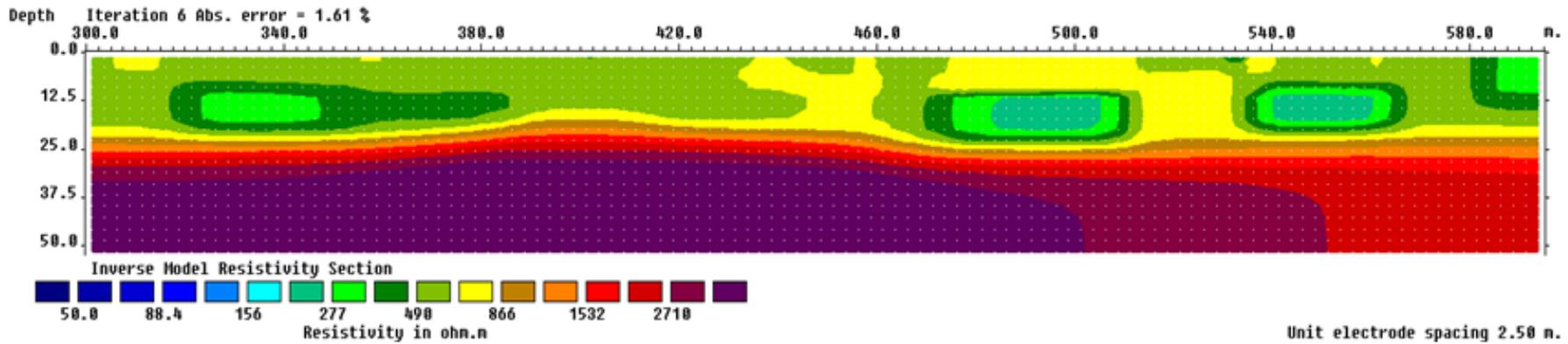
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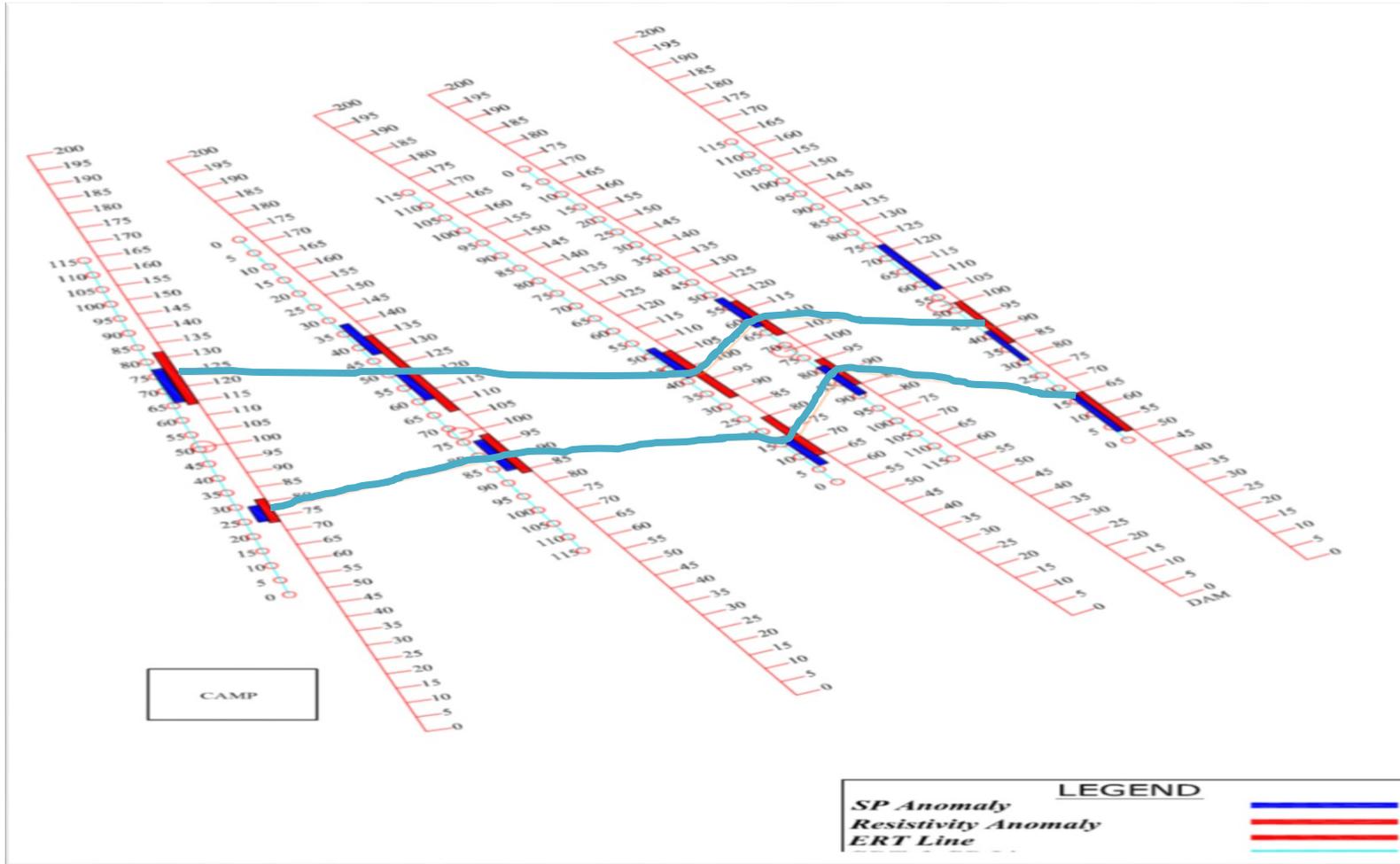
Streaming Potential by Dam Seepage...



SP Results (with ERI)...



Seepage Paths...



Which Technique/ Tool?

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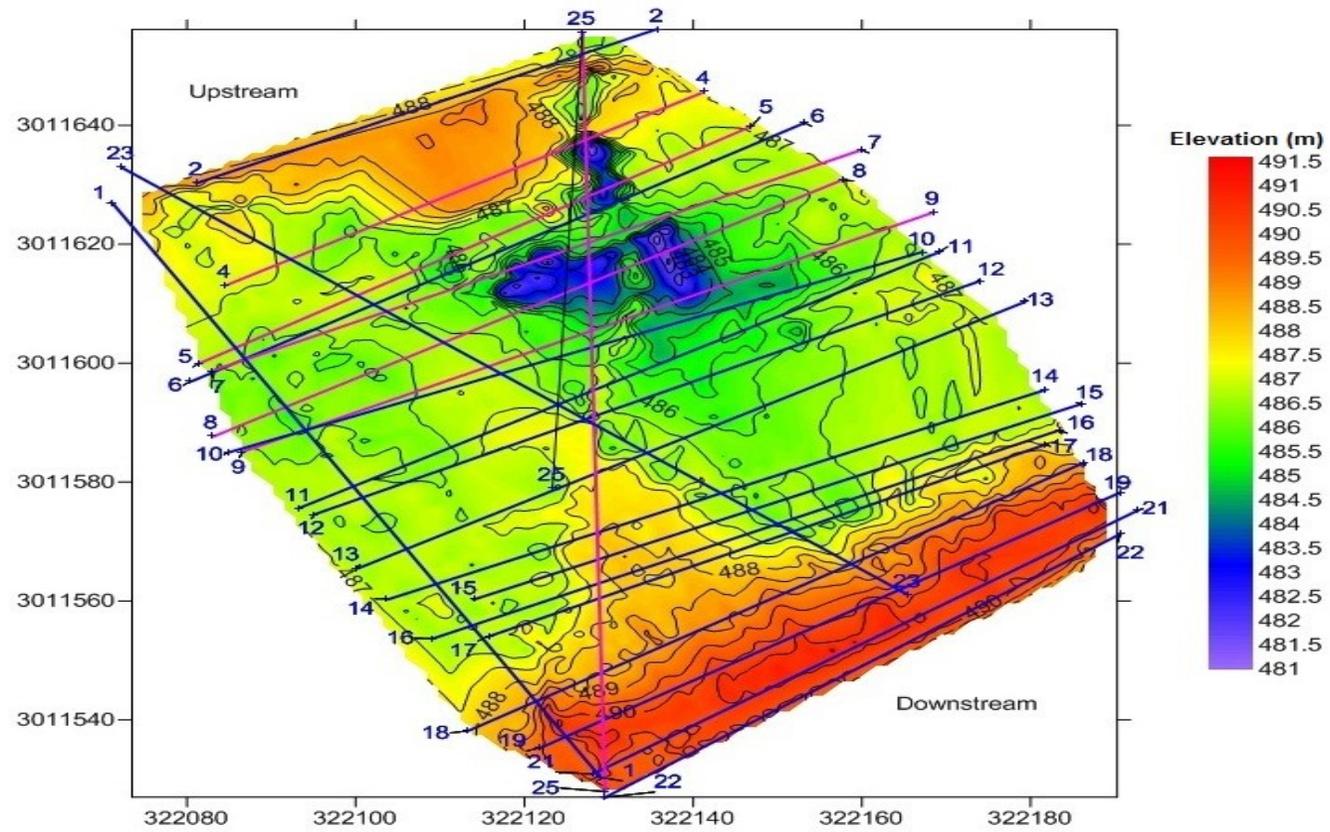
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GPR- Stilling Basin...



Stilling Basin

GPR- Results (Stilling Basin)...



Actual Condition (Stilling Basin)...

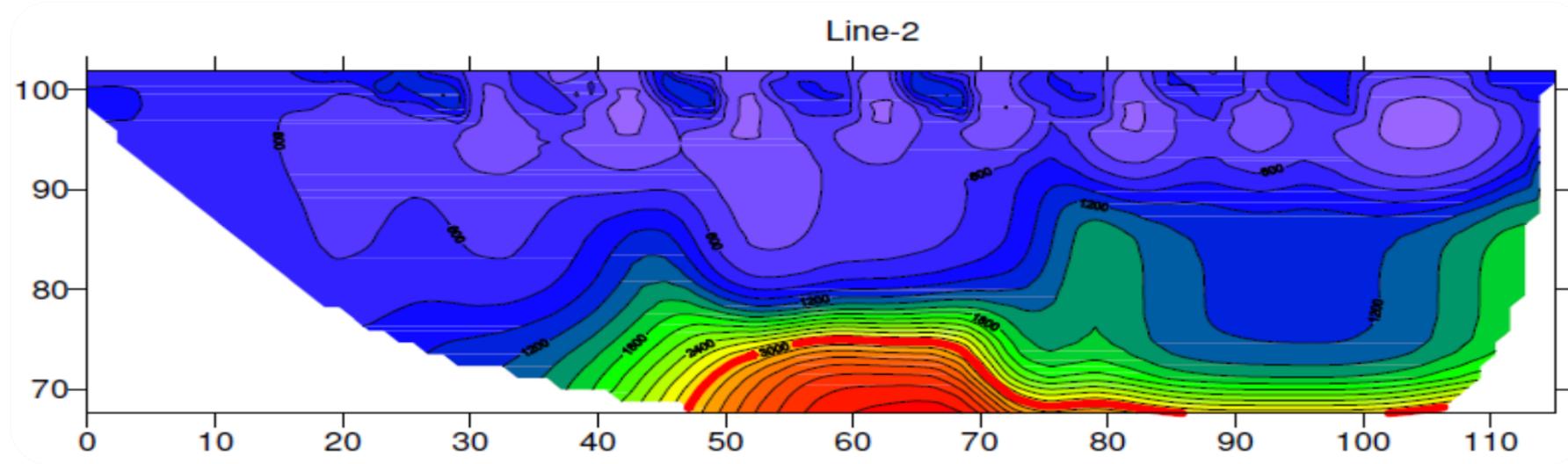
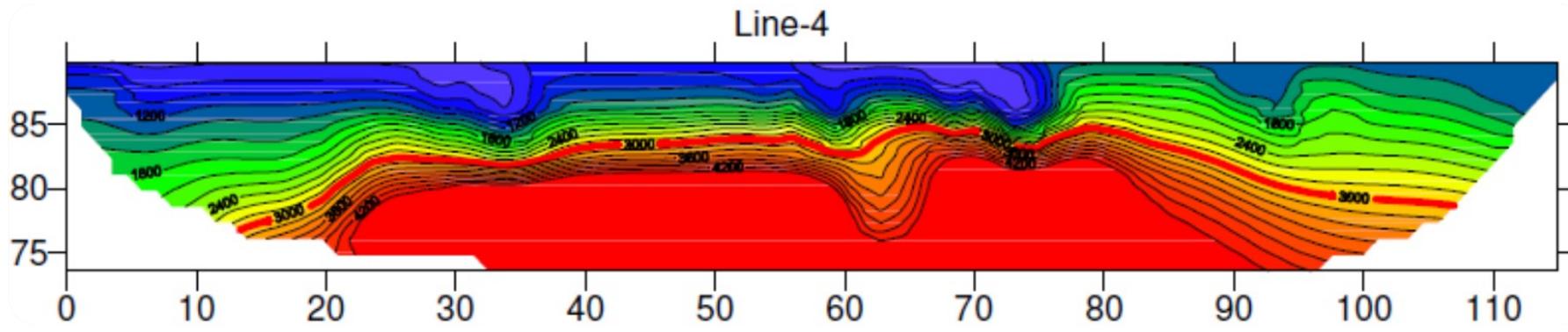


Which Technique/ Tool?

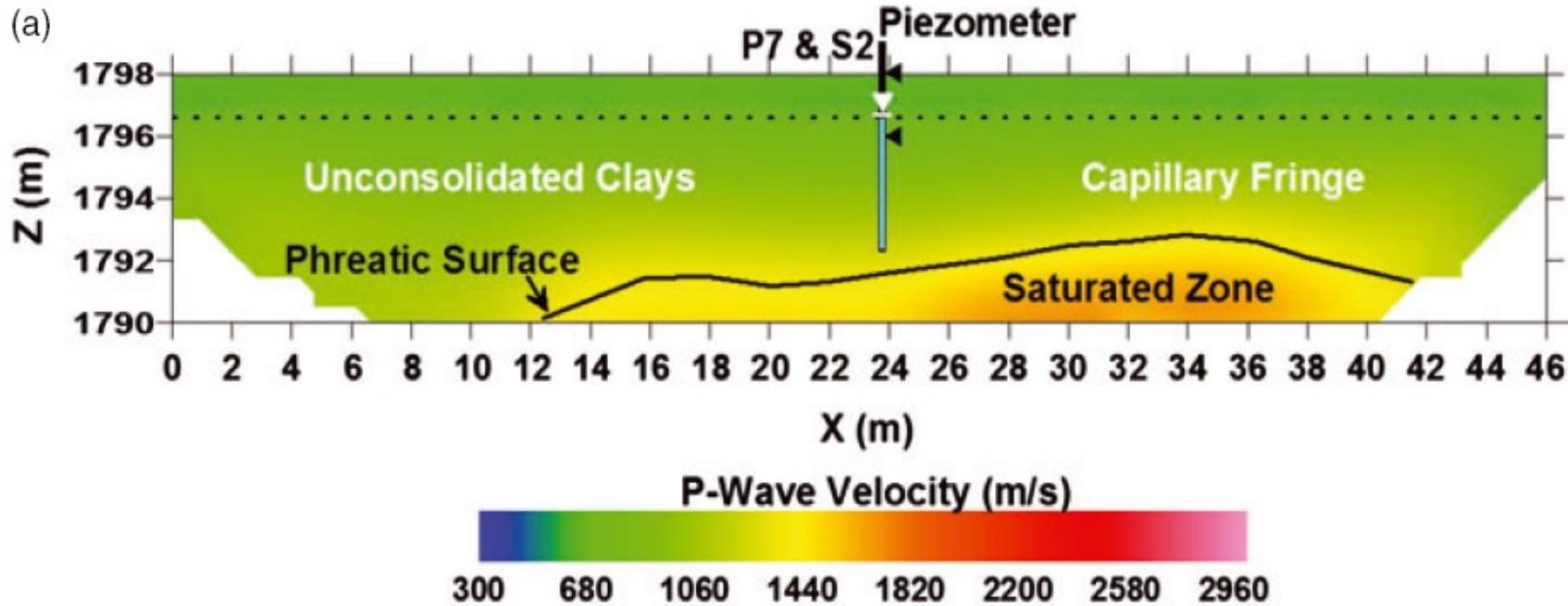
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Seismic Refraction- Dam Body Velocity Model...



Seismic Refraction- Phreatic Surface...

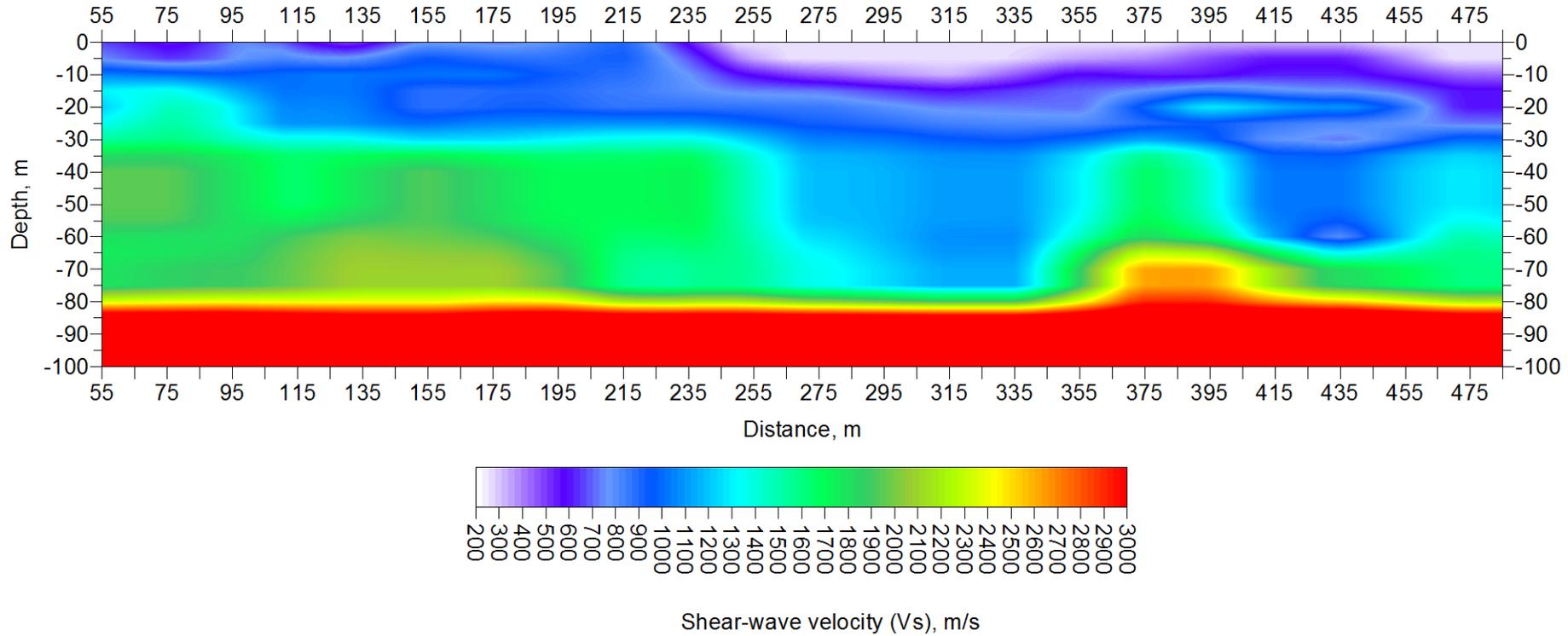


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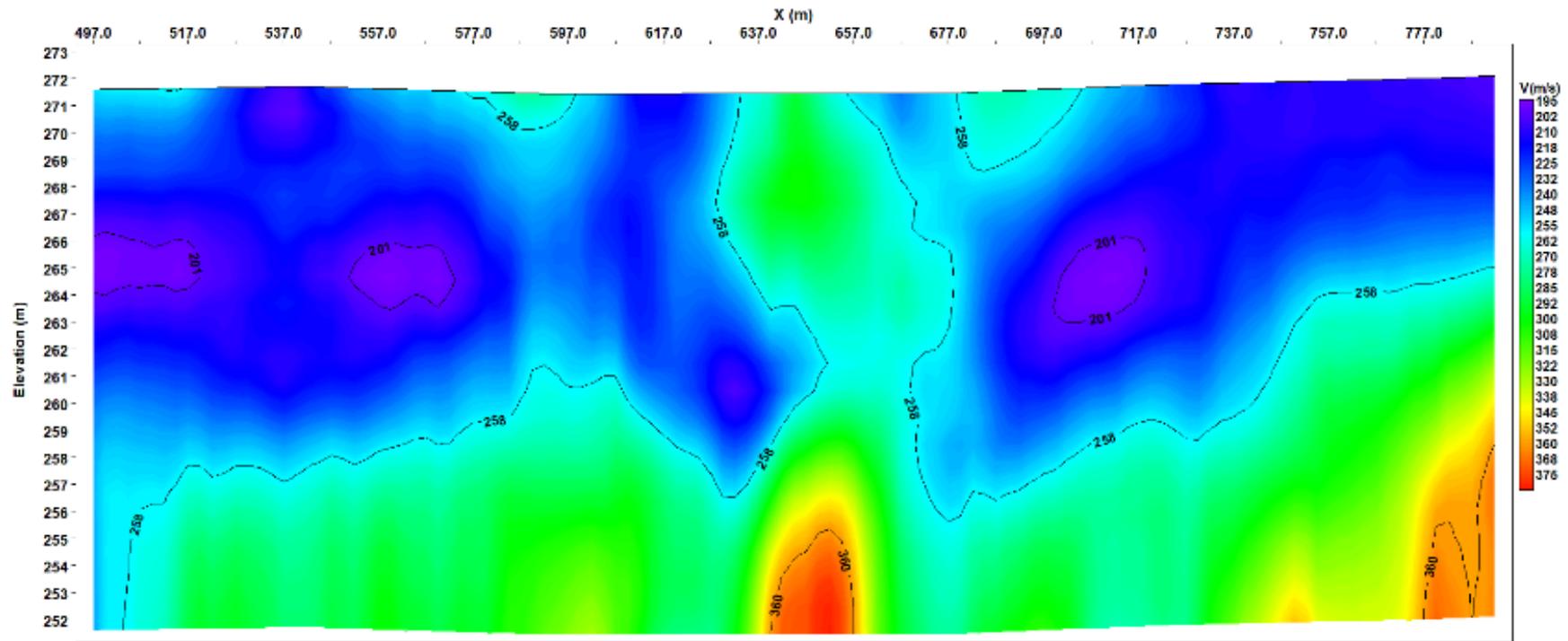
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ReMi Results...



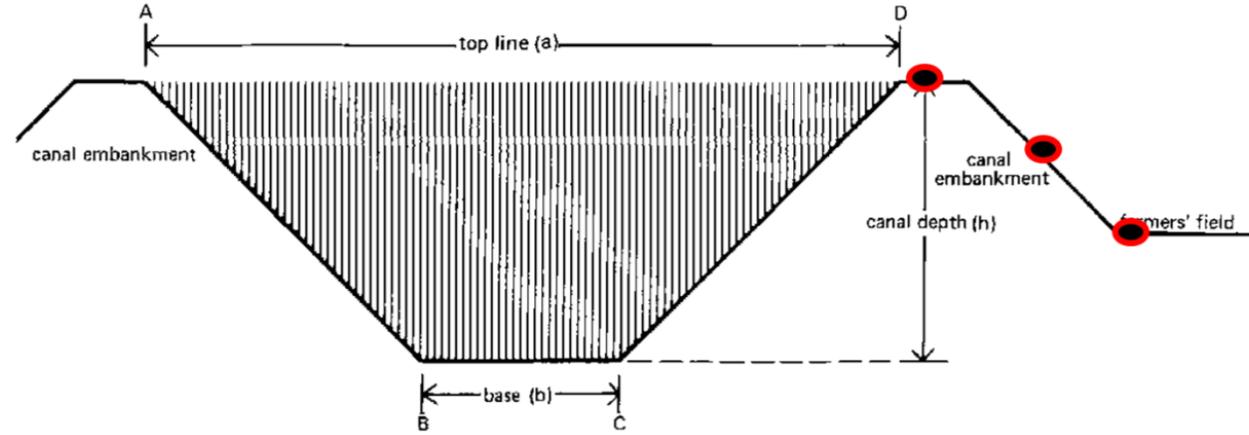
MASW Results...



Which Technique/ Tool?

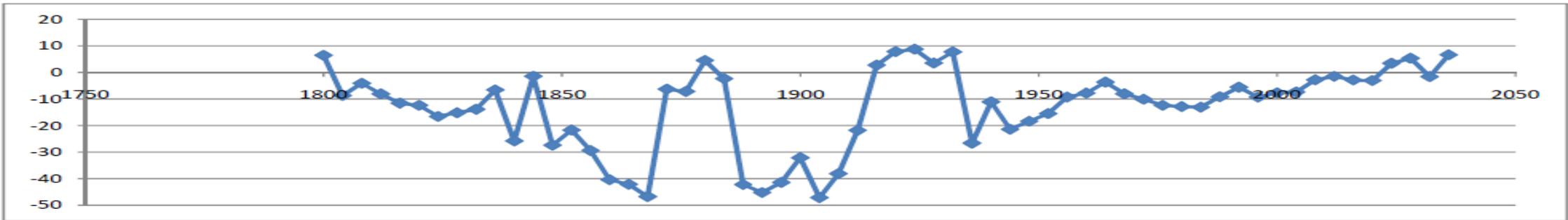
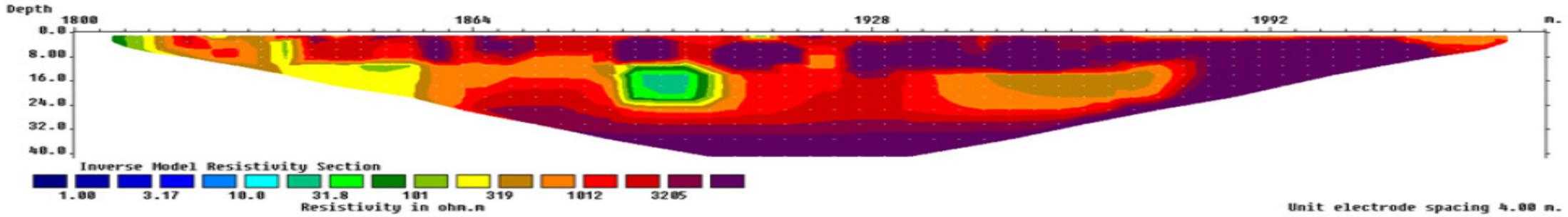
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**Chainage 1800-2036
Near Canal**

Ch1800-2036-Near Canal,,



When do you need to investigate your dam?

- It is desirable to have a 'base line' data of dam **soon after completion of dam.**
- For older dams, **this time is 'now'.**
- Before designing **rehabilitation** plan
- After carrying out rehabilitation works (**to check efficacy**)
- 'Changes' in physical properties are much easier to interpret than one time measurement values.
- Under 'normal' conditions, such measurements should be **repeated every couple of years** as a routine dam inspection program.



Conclusions & Recommendations

- Geophysical investigations **must be made an integral component of dam safety inspection programs/ procedures.**
- Periodic inspection must be carried out on all large dams to detect problems at **early stages**
- Geophysical investigations **MUST be carried out before designing the rehabilitation program, and after rehabilitation.**
- These methods has great potential for other applications like canal seepage studies, stilling basin checks etc.
- **Geophysics presents a viable option to conduct scientific inspection & investigations of more than 6,000 specified dams within next 5 years as stipulated in Dam Safety Act 2021.**
- Guideline document is already available for geophysical investigations for dam safety, which should be deliberated upon and adopted.

Thank You

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