Monitoring Water Content at Intermediate Scales with Electrical Resistivity Tomography

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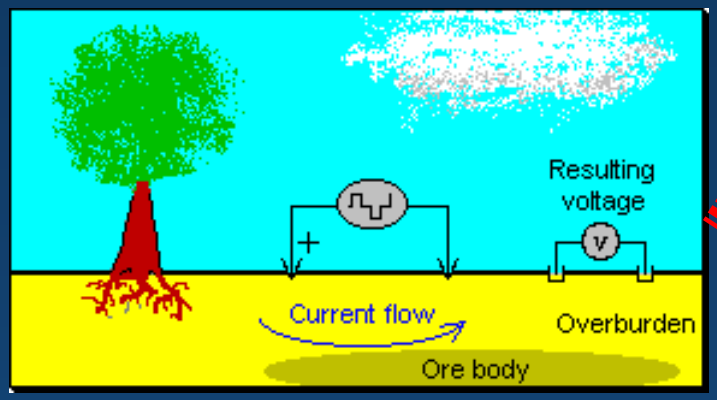
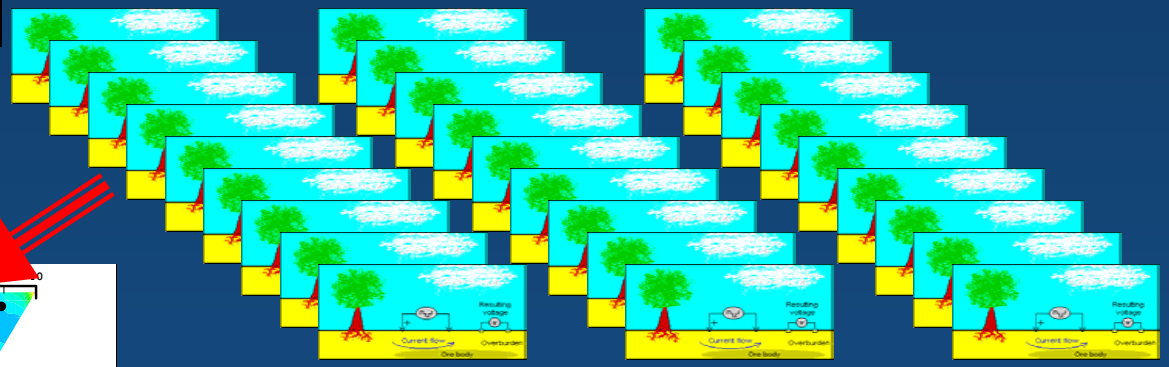
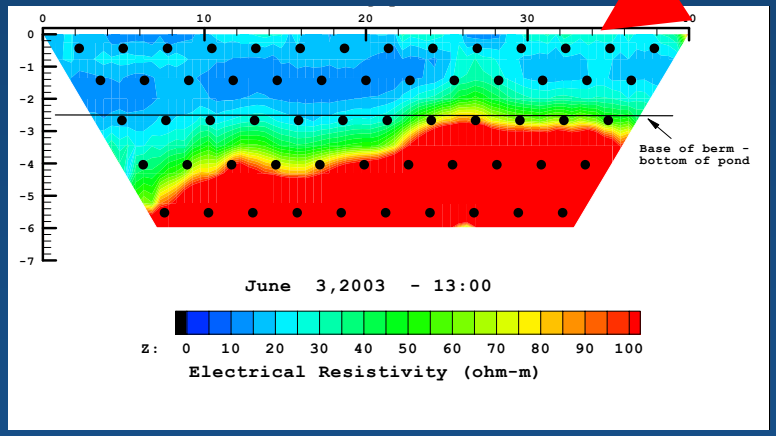
Electrical Resistivity Tomography



Single measurement



Multiple measurements
(different electrode locations)

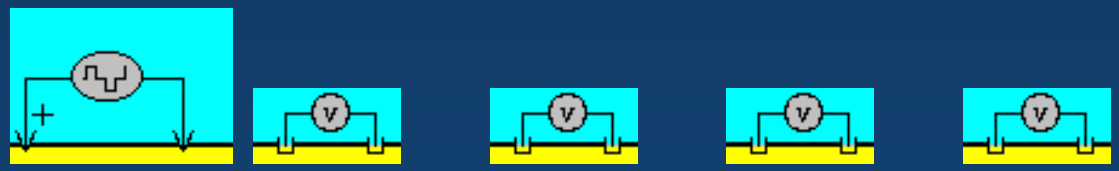


Inverted resistivity image

Electrical Resistivity Tomography

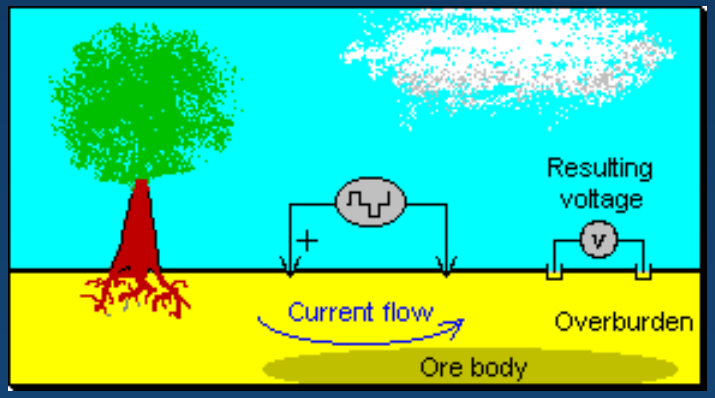
Each measurement is fast.

Electrical Resistivity Tomography



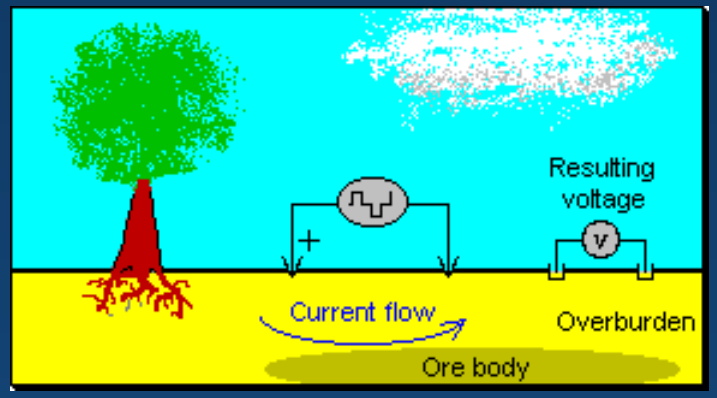
But, there are many combinations of measurements.

Electrical Resistivity Tomography



Survey design requires choices regarding the likely utility of different measurement sets.

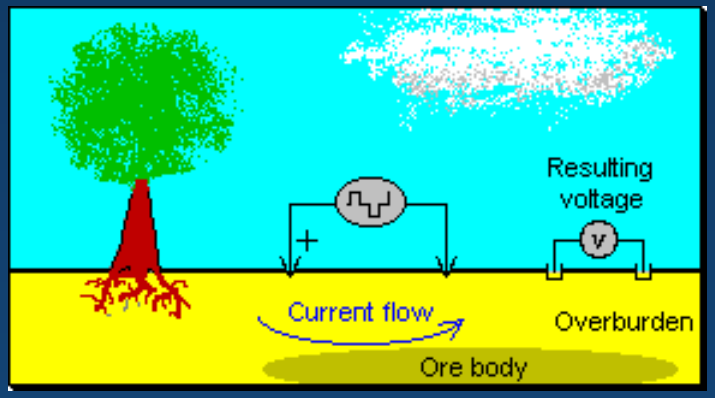
Electrical Resistivity Tomography



Survey design requires choices regarding the likely utility of different measurement sets.

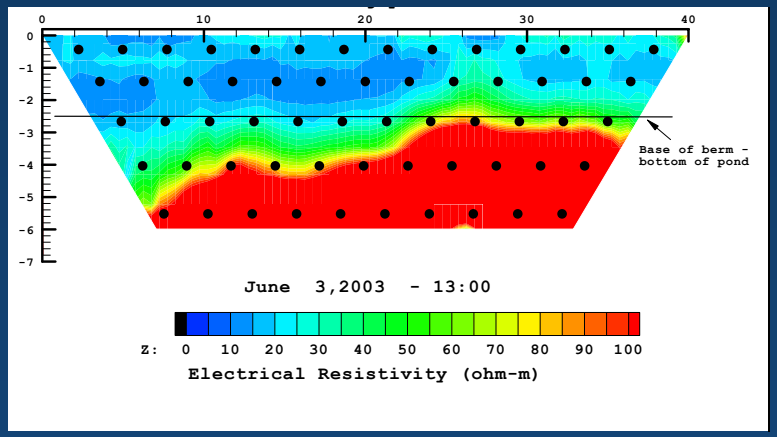
This is true of all monitoring network designs, regardless of the method(s) used.

ERT Challenges



1. Identifying measurements that are likely to form a useful measurement set.

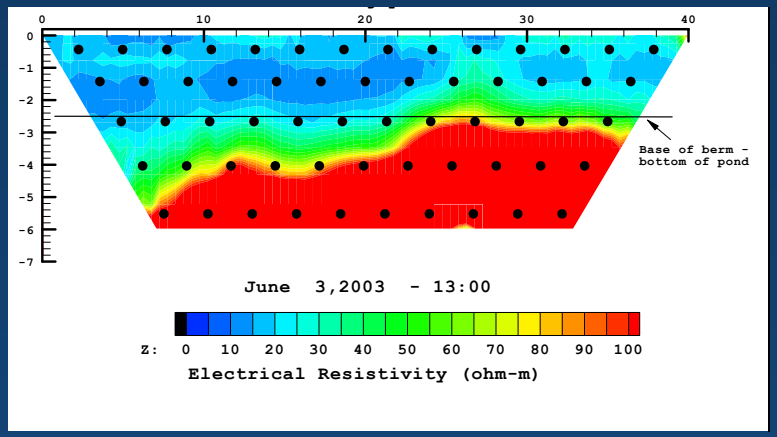
Electrical Resistivity Tomography



Inverted resistivity image

ERT images are interpreted using tomographic techniques. These generally require ***regularization*** to account for nonuniqueness.

Electrical Resistivity Tomography

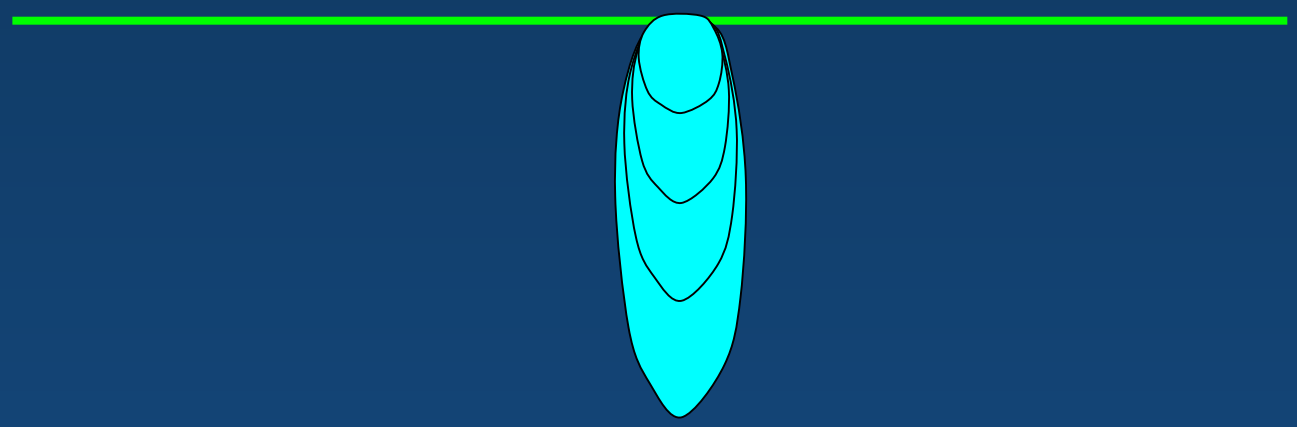


Inverted resistivity image

ERT images are interpreted using tomographic techniques. These generally require ***regularization*** to account for nonuniqueness.

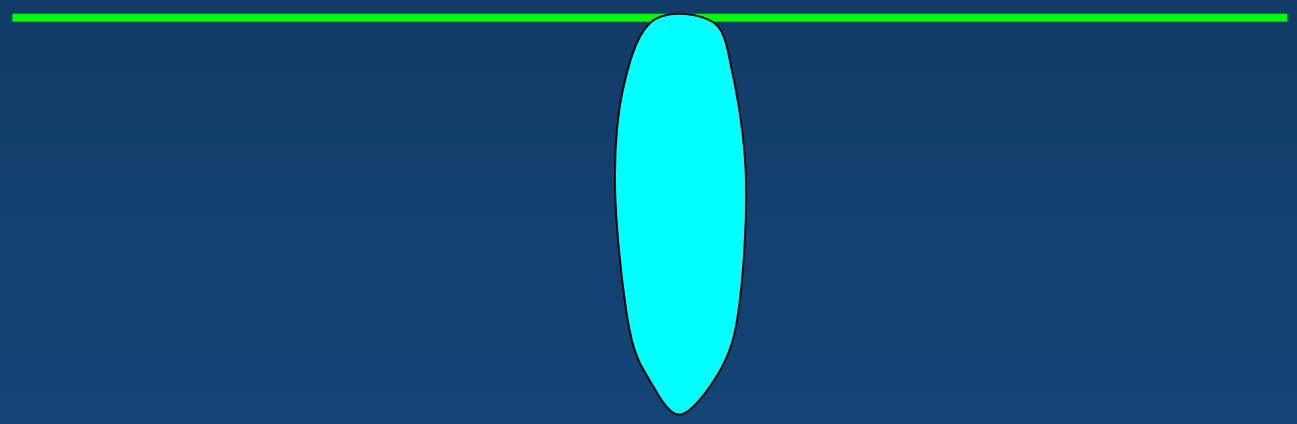
Regularization imposes assumptions about the distribution of electrical conductivity on the interpretation.

Point Irrigation



Typically, we have a (hydrologic) model or models in mind that we will use to interpret the (ERT) data.

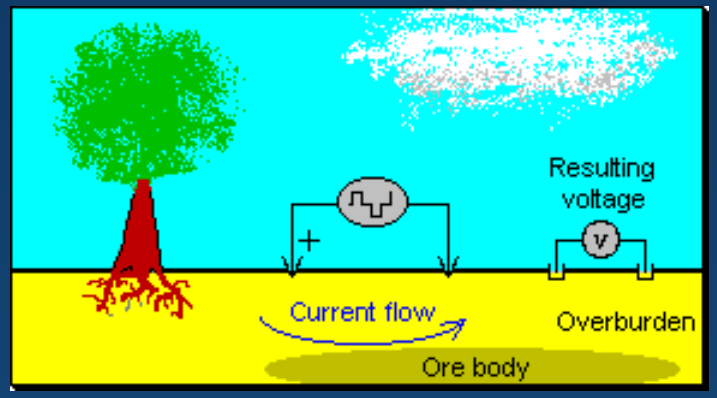
Point Irrigation



Typically, we have a (hydrologic) model or models in mind that we will use to interpret the (ERT) data.

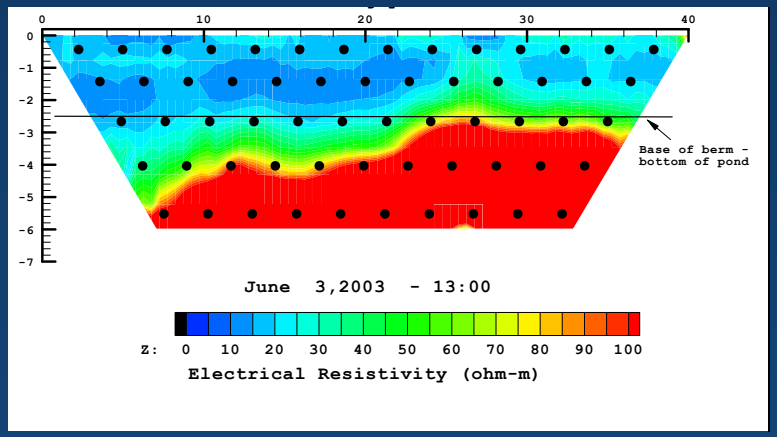
We should be using this model to regularize our ERT data through coupled physical and instrument response models.

ERT Challenges



1. Identifying measurements that are likely to form a useful measurement set;
2. Develop coupled hydrogeophysical models to improve measurement interpretation.

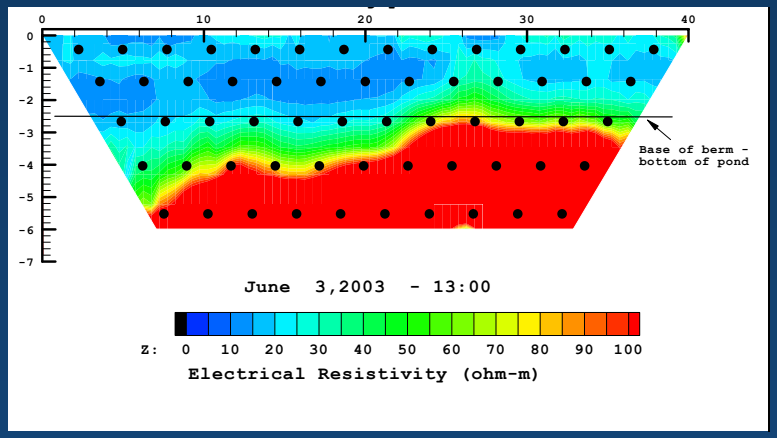
Measurement Evolution



Inverted resistivity image

Typically, the (ERT) measurement network is defined before measurements begin and then rarely, if ever, modified.

Measurement Evolution

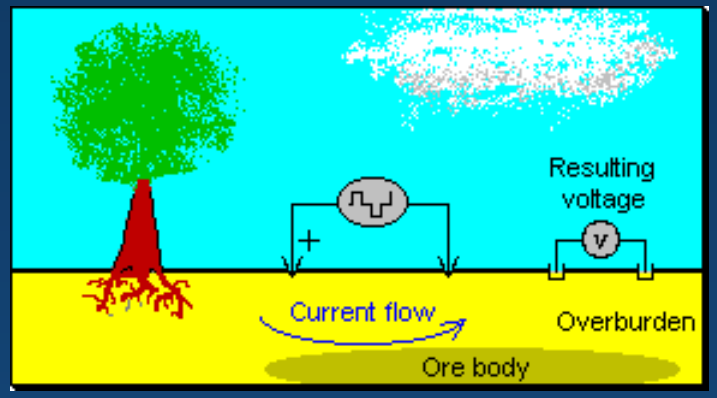


Inverted resistivity image

Typically, the (ERT) measurement network is defined before measurements begin and then rarely, if ever, modified.

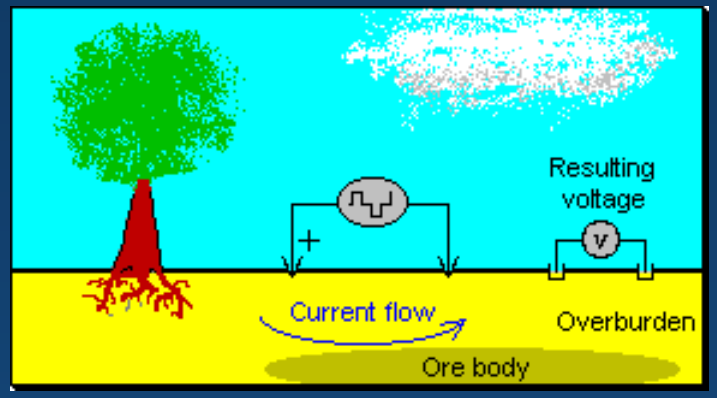
But, early measurements should refine our (hydrologic) model. They should also change our definitions of which future measurements will be most informative.

ERT Challenges



1. Identifying measurements that are likely to form a useful measurement set;
2. Develop coupled hydrogeophysical models to improve measurement interpretation;
3. Develop methods for automated measurement network evolution.

ERT Challenges



- ✓ Identifying measurements that are likely to form a useful measurement set;
- ✓ Develop coupled hydrogeophysical models to improve measurement interpretation;
- ➢ Develop methods for automated measurement network evolution.

SM*Art* Measurement

Sequential Measurement Adaptation in Real Time

- Continually update our models with all available information to make short-term predictions of likely behaviors;
- Then collect the measurements that are most likely to discriminate among models;
- Repeat until there is a low likelihood that additional measurements will discriminate among candidate models.

SM*Art* Measurement

Sequential Measurement Adaptation in Real Time

- Simultaneous consideration of multiple conceptual models to identify discriminating measurements;
- Model-elimination approaches for robust use of multiple data types;
- Prediction-focused measurement targeting capability;
- Built-in cost:benefit analysis of future measurements to provide objective measurement stopping criteria.

SM*Art* Measurement

An objective, flexible approach to providing the most cost effective and informative measurements for testing conceptual models and calibrating models for prediction.