

## Critical Zone Measurements: Development of Novel Experimental Deployments to Further Our Understanding of Hydrological Processes



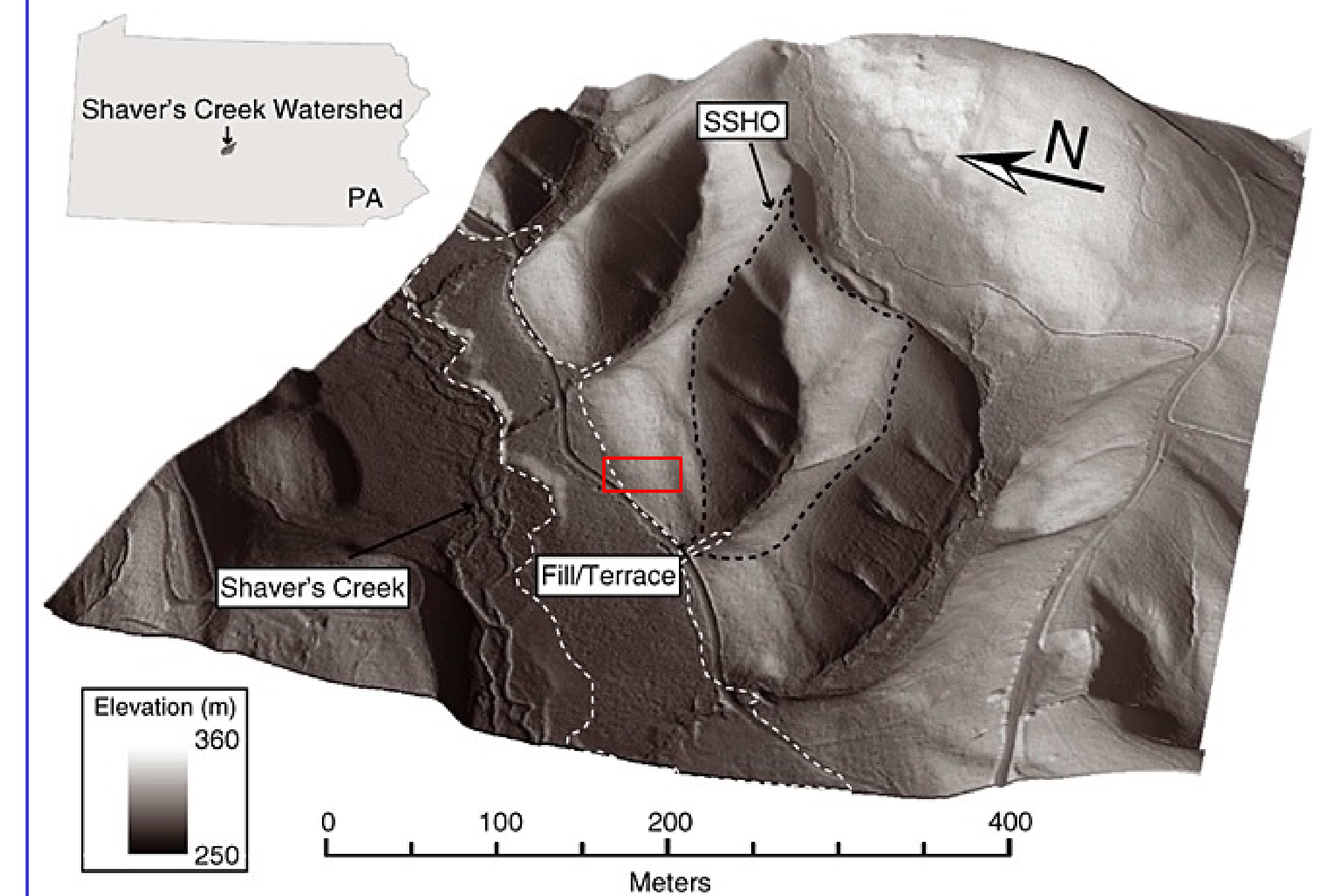
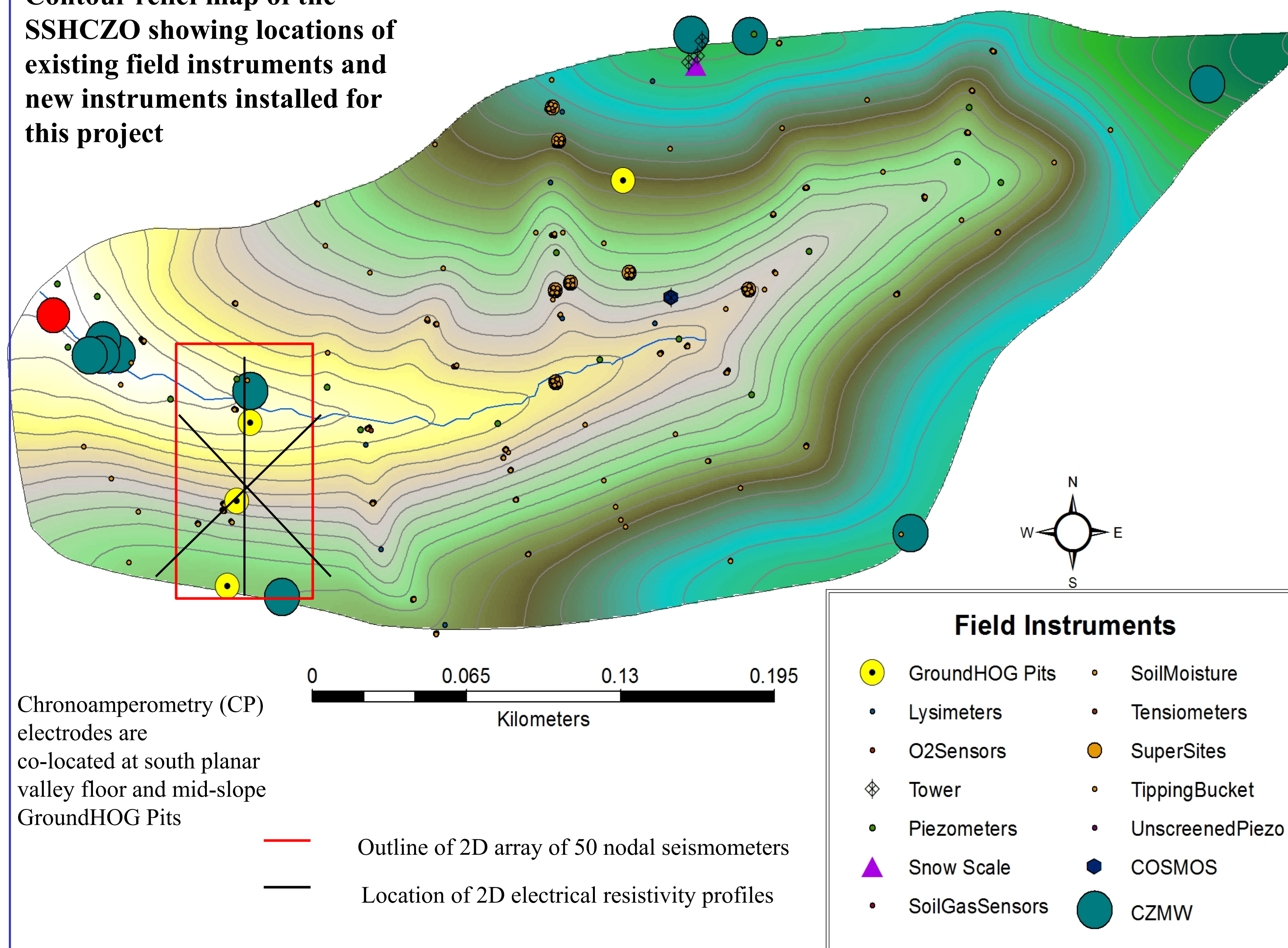
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### Abstract

Since 2013 Susquehanna Shale Hills Critical Zone Observatory (SSHCO) has been monitoring using a Ground Hydrological Observation System (GroundHOG) design consisting of various sensor types in the Shavers Creek watershed in central Pennsylvania. The GroundHOG design was established to study interactions between hydrological systems (surface and groundwater), soils, and ecosystems along catenas. We currently have three GroundHOG sites with differing land uses and geology: one located in a pristine shale watershed, another in a pristine sandstone watershed, and the third in an agricultural setting with mixed lithology. Each catena has three pits set up to compare hill slope position and one additional pit to compare north versus south aspect. Each pit is equipped with both automated and manual sensors that measure soil moisture and soil gas at varying depths. The GroundHOG deployment is accompanied by precipitation gauges, surface water monitoring gauges, and groundwater monitoring wells at all sites. In 2019 we built on the shale site to include electrical resistivity measurements and seismometry near the south GroundHOG sites. Specifically, we designed and installed an innovative chronoamperometric system which show responses to real-time redox reactions which vary corresponding to changes in soil moisture, temperature, and saturation. These experimental sensors are co-located with the GroundHOG sites where soil gas measurements take place and can be coupled to understand the connection of hydrological processes to microbial communities.

Contour relief map of the SSHCO showing locations of existing field instruments and new instruments installed for this project



3D shaded relief map of the Susquehanna Shale Hills CZO (West et al., 2013). Red rectangle shows approximate location of new field instruments installed for this project

GroundHOG Sites – Original site instrumentation includes soil moisture and gas sensors, and lysimeters. These measurements lead us to other novel monitoring ideas including continuous bioelectrodes, time-lapse ERI measurements, and seismologic studies



Oxygen Sensor



Manual Gas Tubes & Measurements



Lysimeters



Carbon Dioxide Sensor



Soil Moisture

Using bioelectrodes to monitor subsurface reactions through chronoamperometry



Graphite electrodes and reference



Potentiostats maintain a constant potential.



Graphite electrodes and reference sensors installed at 50 and 70cm

Time-Lapse seismology and electrical resistivity for elucidating changes in perched water and water-caused dilation



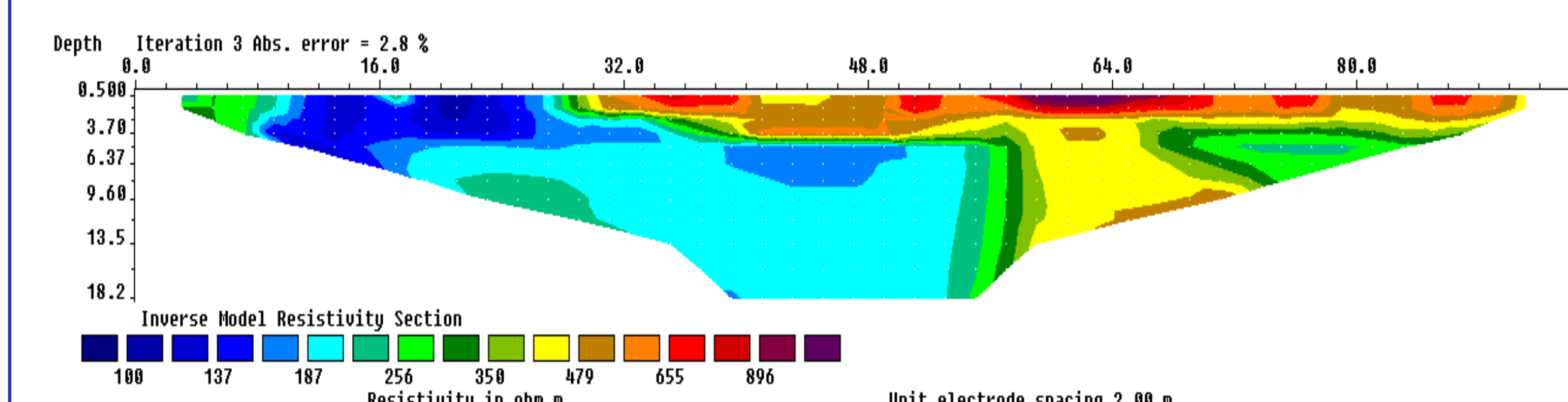
48-channel electrical resistivity meter and cables



3 channel seismic sensor and data logger



Seismic node deployment



Resistivity model for line dip line showing much lower resistivities in the upper 5m near stream and location of one CP electrode.