

RESOLVING THE BASE OF PERMAFROST WITH ERT DEPTH ELECTRODES

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The energy balance of permafrost depends on omnidirectional thermodynamic and hydrologic gradients. Frequently, studies focus on top-down permafrost thaw in the form of maximum seasonal surficial thaw depth, i.e. active layer thickness—which is used to approximate permafrost vulnerability. However, bottom-up warming has the potential to degrade permafrost more quickly than the top-down energy transfer depending on subsurface conditions. Heat fluxes from geothermal gradients and seasonal groundwater flow can contribute to net permafrost inventory reduction by causing melt within and beneath permafrost. Unlike the active layer, there is no impermeable ice layer to restrict groundwater infiltration, as such the melt water simply rejoins the groundwater. Electrical resistivity tomography methods consistently delimit the lateral extent of shallow permafrost and provide active layer insight; however, limitations in the method restrict the ability to accurately detect and image the bottom of permafrost. When a semi-continuous layer of highly resistive permafrost is present, the measurement geometry of a surface based ERT array is such that signal cannot efficiently penetrate the formation and thus provides an inaccurate depiction of the bottom of permafrost. This phenomenon is present in many layered ERT datasets. High-contrasts in subsurface resistivity layers result in signal attenuation, creating a shadow zone. Further, this erroneous lower layer estimate will likely skew overall permafrost inventory estimates where ERT is used as the primary mapping technology. Here, we demonstrate forward ERT modeling results and a field dataset incorporating depth electrodes to improve the measurement geometry and better resolve the bottom of permafrost. Future work will seek to add additional depth electrodes and monitor the seasonality of the base of permafrost.