Calculation of optimal noise levels for the detection of conductive lenses in permafrost with low frequency pulsed radar scans

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Abstract— We present results from numerical simulations of reflection scans with a low frequency pulsed radar system through permafrost host rock with embedded target layers of highly conductive sulfides. The goal of the simulations is to determine the signal to noise ratio needed to detect targets at various depths. Sulfide layers are of interest for mining as they often contain minerals. These layers are typically mined at depths up to a kilometer or more, and the question arises if they can be detected from the surface with a remote sensing method. At these depths seismic methods are not feasible because the targets do not have a strong density contrast, and therefore generate no appreciable reflections. However, as permafrost is highly resistive with resistivities up to 1MΩ [8,] the host rock is almost transparent to electromagnetic waves, and the sulfide layers act as mirrors due to their high conductivity, suggesting a survey with a pulsed radar system [4, 5,]. Feature detection down to several kilometers below the surface has been achieved with low frequency ($1 - 5$MHz) pulsed radar surveys in resistive environments such as Martian rock, ice, and permafrost [2, 3, 1,]. Using such methods a reflector which is probably liquid water was recently detected on Mars at a depth of 1500m [6,]. The simulations are based on the emission and detection properties of the Adrok radar system [7,] in a permafrost environment in which we place a conductive reflector (representing the mineral target) at various depths.

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