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Under-freezing Temperatures are Necessary for Electrical Conductivity in Permafrost Geophysics

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Description

Permafrost islands can be hidden in the unfrozen soil in permafrost-degraded areas. From an engineering or geological standpoint, it is more challenging to analyse permafrost when it is structured in this discontinuous form. The dry density, temperature, moisture content, and pore water resistivity of the soil, as well as the mineral makeup, size, and cementing condition of the soil particles, all affect how resistant it is to freezing. Permafrost has a different resistivity than soil that hasn't frozen because some of the water in the soil pores goes through a phase change as the soil freezes [1]. We examine permafrost's conduction properties. We developed a theoretical model to examine the variables influencing permafrost resistivity.

Next, we conducted an experimental investigation to determine how the resistivity of frozen soil is affected by unfrozen water content, starting moisture content, soil temperature, and dry density. These experimental investigation findings supported the permafrost resistivity model's logicalness. We employed a high-density resistivity approach, which predicts the storage of subterranean geologic formations with varying resistivity based on the distribution of conduction current under the influence of an electric field, to analyse differences in conductivity between underground media [2]. The resistivity profile was obtained for this chapter using the super HDR measurement equipment created by the Chongqing Banteng Numerical Control Technique Research. Based on information obtained through engineering drilling and an examination of the variables affecting permafrost resistivity, a permafrost profile map was created. Analysis of temperature data collected at measured places at various soil depths was done to confirm the accuracy of the permafrost profile map.

The electrical resistivity of a soil is one of its fundamental characteristics. The amount of electrical resistance depends on the soil's mineral composition, dry density, water content, temperature, and structure. The cementation factor was demonstrated to be connected to the morphologies and cementation circumstances of soil particles in a previous experimental work. The findings demonstrated that soil type, mother rocks, soil texture, and soil salt content all affected the electrical resistivity of the soil. Evaluated the connection between a salty soil's electrical resistivity and its salt, water, porosity, and saturation level. The findings demonstrated that when water content, salt content, and saturation level increased, the electrical resistivity of the saline soil decreased. Additionally, it grew as the porosity increased. The electrical resistivity of a soil reduced with increases in the liquid limit or the plastic limit of the soil the impact of a soil's particle composition on that property [3].

Fortier carried out a calorimetric experiment on an undisturbed, frozen soil sample and discovered the sample's unfrozen water and ice contents. Fortier measured the electrical resistivity close to the sampling site and, using a linear regression analysis, established the relationship between the electrical resistivity and the contents of unfrozen water and ice. Delaney reported on a study of the electrical resistivity of frozen and petroleum-polluted soils. They discovered that the soil's electrical resistance might rise as a result of both freezing weather and petroleum pollution. The spatial distribution of the island-shaped permafrost layer along the was also investigated using the electrical resistivity approach. The upper and bottom surfaces of the island-shaped permafrost layer showed discontinuities in the electrical resistivity, and the permafrost layer had very high resistance. The areas without permafrost experienced rather mild variation in electrical resistivity with no discontinuities [4].

In order to fully understand the electrical conductive characteristics of frozen soils, this study examined the relationship between a soil body's electrical resistivity and its water content, temperature, and dry density. For the electrical resistivity of frozen soils, we employed mathematical deduction and a theoretical model. On soil bodies with various water contents and dry densities at various temperatures, experiments were run. We also created a theoretical foundation for investigating the distribution of subterranean shallow frozen soils using the electrical resistivity approach, and we confirmed the validity of the theoretical model for the electrical resistivity of frozen soils [5]. Geophysical analysis has proliferated as a popular approach in research that assesses stratigraphic dispersion in recent decades. The physical characteristics of rock and soil that are connected to their lithological, hydrological, and geotechnical characteristics can be measured directly or indirectly using in situ geophysical techniques. These physical detection methods are non-destructive and can resistivity method compared to other ground detection technologies like as drilling, clinometric, and laboratory testing. To circumvent the point scale constraints of common geotechnical measurements, integrate the data gathered over huge soil volumes. An in situ geophysical method called the high-density resistivity method is increasingly used in landslide and permafrost geological studies.

Conflict of Interest

None.

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