Estimation of thermal resistance of soil around underground power transmission line using geophysical surveys

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The thermal resistance of soil around underground power transmission lines is an important parameter affecting transmission capacity. Thermal resistance of soil is conventionally measured by inserting a heating element and a thermocouple into a borehole. Because, this method is expensive, the thermal resistance is often assumed to be the standard value (80℃cm/W). However, this is a conservative estimate, which inadvertently leads to the condition of cables that have a large diameter than is required. Kubota et al. (2015) and Suzuki et al. (2015) suggested a method to estimate the thermal resistance from resistivity data using an empirical formula and artificial soil samples. However, it is important to use the measured resistivity and thermal resistance of actual soil samples surrounding the survey lines. In this study, we propose a new soil thermal resistance model composed of sand particles, clay particles, pore water, and air which was based on the unconsolidated sand model (Avseth, 2005). The theoretical thermal resistance derived by this model is comparable to the saturation–thermal resistance relationship measured by laboratory tests performed on artificial unconsolidated soil samples. Additionally, we propose a method to estimate the thermal resistance profile by combining the S-wave velocity–porosity (Avseth, 2005) and resistivity–porosity relationships (Katsube and Hume, 1983). This method was applied to geophysical survey data obtained using the surface wave and the electrical methods in the field where underground power transmission lines are planned. Thermal resistance profile obtained using integrated geophysical data matches the values measured directly in the borehole drilled along the survey line (Fig.1). In conclusion, this method is suitable for use in designing power transmission cables.

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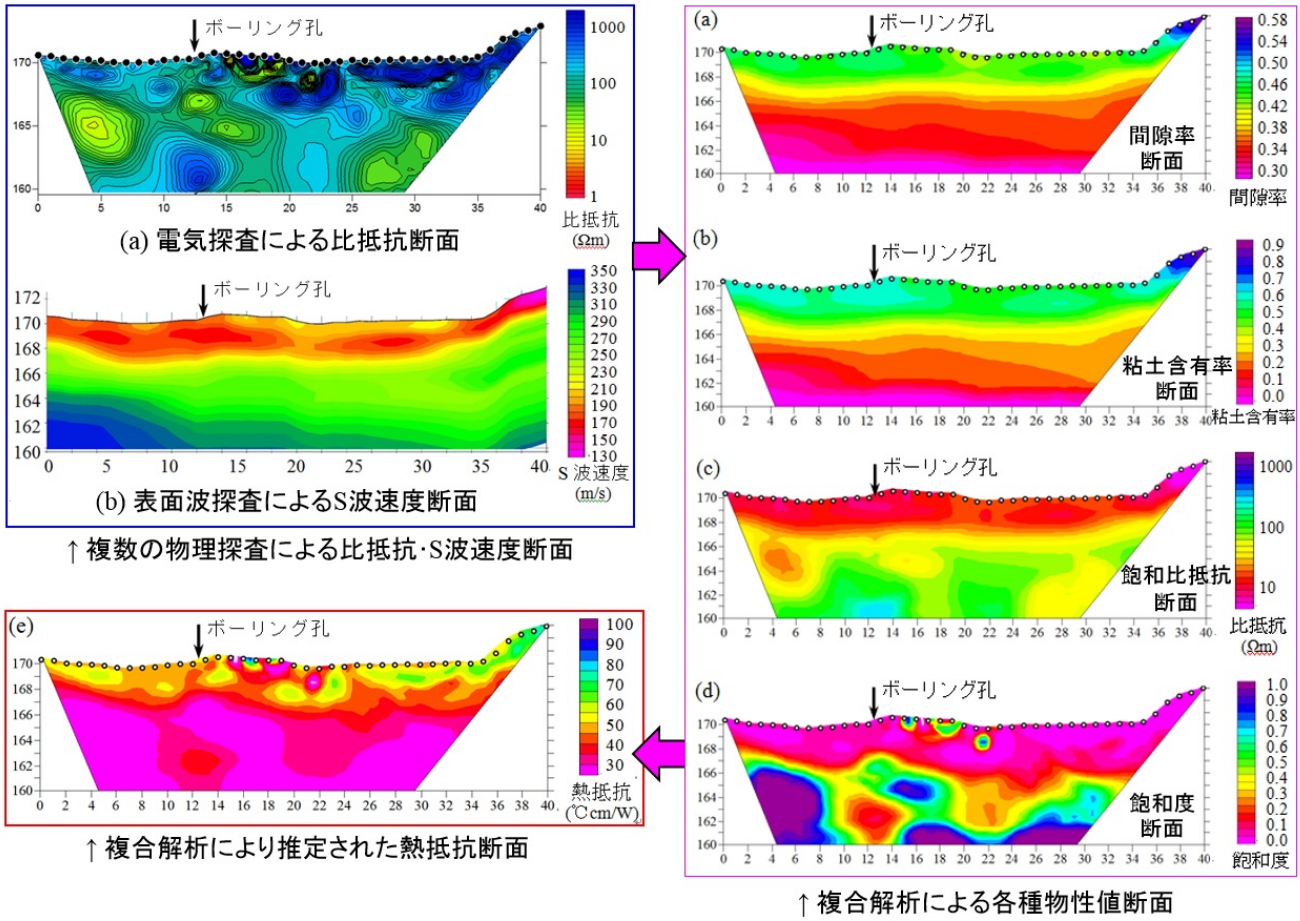

図1 電気探査&表面波探査による熱抵抗分布の推定