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COMBINING AND INTERPRETING GEOELECTRIC AND SEISMIC SURVEYS IN PERMAFROST STUDIES USING FUZZY LOGIC

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For many problems in permafrost studies geophysical investigations are the main source of information concerning the structure and characteristics of the subsurface. Especially the ability to gather 2-dimensional information about the subsurface material is considered the main advantage of geophysical techniques as opposed to the single-point information through boreholes. However, the indirect nature of geophysical surveys, where material properties like water content, ice content or temperature have to be inferred from the measured physical variables such as electrical resistivity, can be considered a major drawback for the application of geophysical methods in applied geosciences. Nevertheless, the uncertainty in the interpretation of geophysical data sets is seldomly explicitly treated in geophysical applications. In order to address this uncertainty, a model approach using fuzzy logic is presented in this contribution, which is based on expert knowledge on ground ice detection with geophysical techniques.

Fuzzy logic is an extension of a multivalued logic, where classes of objects have unsharp boundaries and membership is a matter of degree. It is a convenient way to map an input space to an output space, especially if a quantitative output is required from imprecise input variables. In this case the input space is comprised by the results from the geophysical surveys (electrical resistivities and seismic P-wave velocities) and the output space is the degree of ice content, that is the possibility of ground ice occurrence. The fuzzy inference system used in this study is of the Mamdani-type and is based on nine rules, all linking low, medium and high resistivity and velocity values to a corresponding output (low, medium and high ice content). Extremely high resistiv-

ity values and medium seismic velocities around 3500m/s (velocity for pure ice) are associated with high ice contents.
First results from model studies with synthetic data sets and field data from presumed low-altitude permafrost sites show promising results for the detection of isolated ground ice occurrences.