

Attempts at relating the electrical transport properties to microstructural characteristics of sea ice, however, have largely been unsuccessful. In particular, there have been no observations of critical behavior in electrical properties corresponding to the important microstructural transition articulated by the rule of fives. Here we report on two types of experiments conducted on sea ice in the polar regions. In both cases we have obtained extensive data on the electrical resistivity which clearly display critical behavior at the brine percolation threshold. Our mathematical description provides a rigorous link between fluid and electrical transport in sea ice, with both properties displaying the same type of universal critical behavior, thus laying the foundation for the types of techniques described above.

In the Antarctic, we have made the first *direct* measurements of the vertical resistivity of sea ice by using a four probe Wenner array on extracted cores. In the Arctic, we have used the emerging technique of cross-borehole DC tomography, utilizing vertical strings of electrodes frozen into the ice. The vertical component of the resistivity is obtained from direct measurements of the horizontal and geometric mean resistivities. Although the two data sets were obtained at opposite poles of the Earth and by quite different methods, they agree closely and are both accurately captured with the same critical exponent from lattice percolation theory used to predict fluid permeability (*16*). Moreover, our Arctic data was taken in late spring and exhibits temporal behavior which is closely correlated with the onset of melt ponds.

The findings presented here also have implications for measuring ice thickness, an important gauge of the impact of global warming. Not only is thickness data important in comparing climate model predictions to observed behavior, but in specifying the initial conditions necessary for long-term numerical simulations. Almost all methods for obtaining such data depend on the interaction of electromagnetic (EM) fields with sea ice. For example, there has been significant interest in the development of EM induction devices (*23,25,26*) mounted on ships, planes and helicopters. These techniques, and the interpretation of the data to