Improved Instrument for Detecting Water and Ice in Soil

This device can be used to assess ice buildup on aircraft.

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An instrument measures electrical properties of relatively dry soils to determine their liquid water and/or ice contents. Designed as a prototype of instruments for measuring the liquid-water and ice contents of lunar and planetary soils, the apparatus could also be utilized for similar purposes in research and agriculture involving terrestrial desert soils and sands, and perhaps for measuring ice buildup on aircraft surfaces.

This instrument is an improved version of the apparatus described in "Measuring Low Concentrations of Liquid Water and Ice in Soil" (NPO-41822), *NASA Tech Briefs*, Vol. 33, No. 2 (February 2009), page 22. The designs of both versions are based on the fact that the electrical behavior of a typical soil sample is well approximated by a network of resistors and capacitors in which resistances decrease and capacitances increase (and the magnitude and phase angle of impedance changes accordingly) with increasing water content. The previous version included an impedance spectrometer and a jar into which a sample of soil was placed. Four stainless-steel screws at the bottom of the jar were used as electrodes of a four-point impedance probe connected to the spectrometer.

The present instrument does not include a sample jar and can be operated without acquiring or handling samples. Its impedance probe consists of a compact assembly of electrodes housed near the tip of a cylinder. The electrodes protrude slightly from the cylinder (see Figure 1). In preparation for measurements, the cylinder is simply pushed into the ground to bring the soil into contact with the electrodes.

A typical measurement run takes several seconds. Typically, the magnitude and phase angle of impedance are measured as function of frequency from 20 Hz to 500 kHz. Figure 2 presents some results of test measurements performed at temperatures from –25 to +65 °C on dry and moist silica sand. From these and other measurement results, it was concluded that, in the aforementioned temperature range, the instrument can detect the presence of water or ice at a concentration as low 0.1 weight percent and can measure the concentration above 0.5 weight percent.

This work was done by Martin Buehler, Keith Chin, Didier Keymeulen, Timothy McCann, Suresh Seshadri, and Robert Anderson of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). ***.*** *NPO-44261*

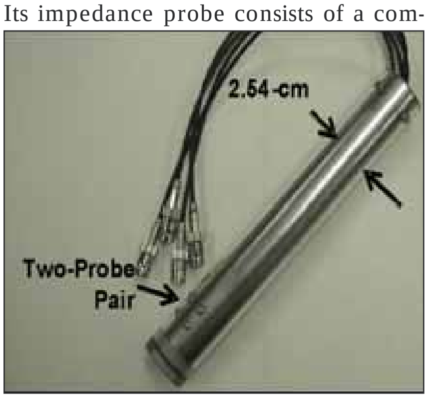

Figure 1. The **Water/Ice Detection Instrument** relies on an electrical properties probe using a two-probe pair. In use, the free end is pushed into the ground to place the electrodes in contact with the soil.

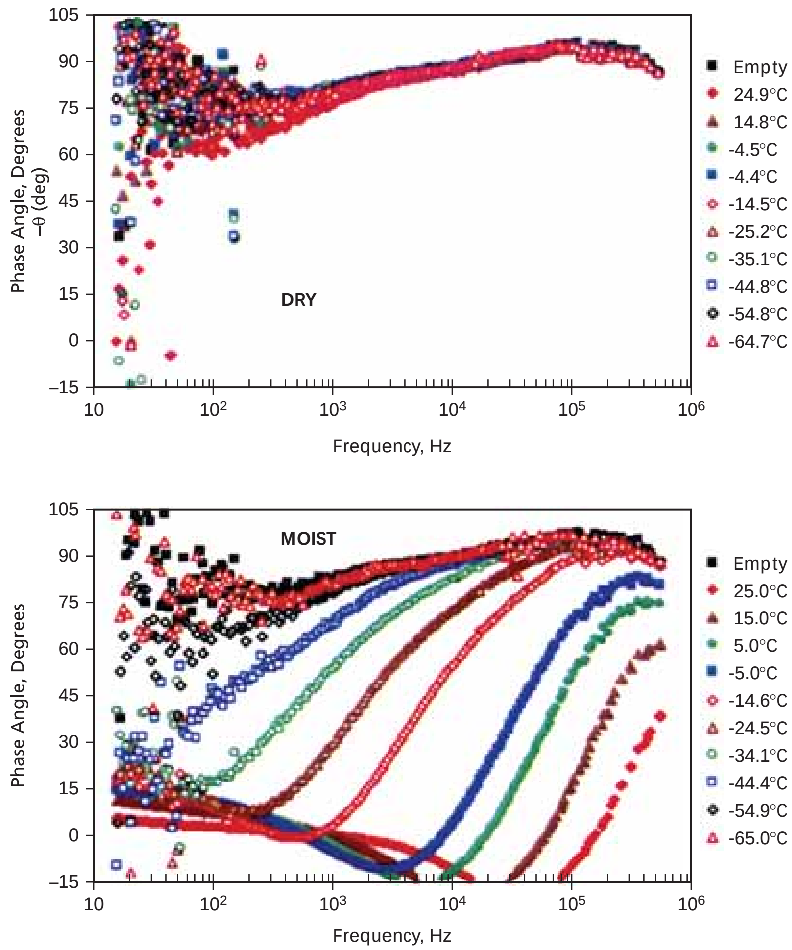

Figure 2. **Phase Angle Versus Frequency** was measured in the "empty" case (nothing in contact with the electrodes) and at various temperatures with electrodes in contact with (a) dry silica sand and (b) silica sand moistened with 0.1 weight percent of a 0.1 M aqueous solution of KCl.