Estimation of ice and liquid water content of two martian analogue soils in a temperature range from 0 °C to -70 °C by means of dielectric spectroscopy

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Recent Mars observations and experimental investigations indicate that water could be a key factor of current physical and chemical processes on the martian surface, e.g. rheological phenomena (Kereszturi et al., 2008, 2010). Therefore it is of particular interest to get information about the liquid like state of water on martian analog soils in the temperature range below 0 °C. In this context, a plate capacitor has been developed to obtain isothermal dielectric spectra of fine grained soils in the frequency range from 10 Hz to 1.1 MHz at martian like temperatures down to -70 °C (Lorek, 2008). Two martian analogue soils have been investigated: a Ca-Bentonit (specific surface of 215 m²/g, up to 9.4 %w/w gravimetric water content) and JSC Mars 1, a volcanic ash (specific surface of 146 m²/g, up to 7.4 %w/w). Three soil-specific relaxation processes are observed in the investigated frequency-temperature range: two weak high frequency processes (bound or confined water as well as ice) and a strong low frequency process due to counter ion relaxation and the Maxwell-Wagner effect (e.g. Stillman et al., 2010). To characterise the dielectric relaxation behaviour a generalized fractional dielectric relaxation model (Wagner et al., 2007, 2011) is applied assuming three active relaxation processes with relaxation time of the i-th process according to an Eyring equation (Wagner and Scheuermann, 2009). The real part of effective complex soil permittivity at 350 kHz was used to determine ice and liquid like water content by means of the Birchak or CRIM equation (Lorek, 2008). There are evidence that bentonite down to -70 °C has a liquid like water content of 1.3 mono layers and JSC Mars 1 a liquid like water content of 2.3 mono layers.

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