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EMC/ERH-properties of thin layers of martian analogue soils – First results

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The water content of soils significantly influences their chemical, physical and biological properties. In equilibrium, this water content can be described by the EMC/ERH ratio (EMC – Equilibrium Moisture Content, ERH – Equilibrium Relative Humidity). In view of Mars, the thin layer of the upper millimetres of the martian surface are of particular interest because this soil interacts directly with the diurnally varying atmospheric humidity, which during night and early morning can reach saturation. Adsorption/desorption of water in the soil and freezing of water can be a consequence.

A measurement system has been developed to determine EMC/ERH ratios for martian thermo-physical conditions. This is based on a plate capacitor with a thin layer of martian analogue soil between the capacitor plates, which is exposed to gas flow of known humidity. The soil adsorbs and/or desorbs water in dependence on the relative gas humidity. The uptake of water will change the permittivity of the soil. Measuring soil permittivity can therefore be used to determine the water content of soil.

In view of the chemically and biologically relevant mobility of adsorbed water, it is also essential to have information about the relative and temperature dependent abundances of liquid water and ice. These can be determined by taking into account that water and ice have different high dielectric permittivity's (80 between 0 Hz and 1GHz for water and 92 between 0 Hz and 10KHz for ice, over 10KHz decrease the permittivity for ice of 3,25), while that of soil is between 3 to 10. The frequency range of the measurements is 10 Hz till 1.1 MHz. Thus, it is possible to differ between liquid water and ice.

Two martian soil analogue have been tested in view of their EMC/ERH ratio and of the relative abundance of liquid water and ice:

1. Bentonit, a clay with a high abundance of Montmorillonite, (which was detected on Mars by OMEGA spectrometer of Mars Express (1) and
2. JSC Mars 1 a volcanic ash with similar chemical contents like the martian soil (2).

The measurements have been performed in a temperature range from +25˚C to -75˚C under air and ambient pressure (Earth) with water partial pressure of 0,12Pa (like Mars (4)).

First results at a temperature of 25˚C and a ERH-value of 0,004 r.h. (r.h. – relative humidity) show for Bentonite an EMC-value of 0,6-0,9 wt% (weight per cent) and for JSC Mars 1 an EMC-value of 1,4 wt% . The material probes were baked out over 24h at 105˚C.

For montmorillonite an EMC/ERH-ratio of 1,5 wt% / 1% r.h. (1 monolayer) and 9wt% / 10% r.F. (6 monolayer) is expected (3). The measurements indicate that at a temperature of -75˚C about two monolayers of water are in the liquid state.

Experiments are in preparation measure EMC/ERH ratios and liquid water/ice content under martian diurnally varying conditions, i.e. at a pressure of 600 Pa, a temperature range from +20˚C to -75˚C and an atmospheric humidity between saturation and nearly zero.

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