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A broadband frequency characterisation of Martian analogue dielectric behaviour

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We report on the development of a database including electrical properties of Martian analogue material, which shall support planetary data analysis.
In the last two decades a vast amount of data concerning the electrical properties of the Martian surface and subsurface layers has been obtained. With the joined ESA/NASA Mars program in the upcoming years, these data will even be expanded. As a support for the data-evaluation our group performed laboratory investigations to characterise the electrical properties of several Martian analogue samples under controlled conditions. The common mechanical analogue material JSC-Mars 1A as well as some European materials (e.g. Salten Skov from Denmark) are characterised in a broad frequency range (1 Hz – 20 MHz), which includes GPR investigations as well as probably future instruments working in the audio-range. This broad frequency range was selected to get a better understanding of the properties effecting the electrical parameters of the investigated samples. In the very end of the evaluated frequency range the electrical properties are mainly determined by their physical properties, like their bulk density. In the lower frequency region the data is strongly influenced by the overall chemical composition. As an example small amounts of iron-oxides change the electrical properties in a significant way.
In our laboratory work a special focus was given to the properties of JSC-Mars 1A, the most common Martian analogue material. Under controlled low vacuum conditions the fractional composition of a JSC-Mars 1A sample to some iron bearing minerals was changed. This treatment leads to the main influencing parameters determining the electrical properties of the Mars analogue material. In this sense we took various mixtures of JSC-Mars 1A with hematite (Fe_2O_3), goethite ($FeO(OH)$) and other iron bearing minerals in our database. The obtained functionality between several volume-fractions of the minerals and JSC-Mars 1A generally varies in the considered frequency ranges. Nevertheless our work could support the evaluation of acquired mission data. Carefully considered error assumptions improve therefore additionally the overall validity.
Concerning validity issues the evaluated data has been compared to common mixing theories of dielectric material. Well known models like the Lichtnecker-Rother formula or the Maxwell-Wagner-Bruggeman-Hanai formalism have been applied on the data for various frequency ranges and chemical compositions. These evaluations will improve the dielectric data modelling as well as its analysis.