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Simultaneous measurements of strength and water content or air-filled porosity for estimating thermal conductivity of terrestrial soil media

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Thermal conductivity of porous media is required in numerous areas of terrestrial and extraterrestrial objects. Measurements of the conductivity are however still difficult and expensive. Therefore multi-sensor systems for measurements of strength and thermal conductivity are used particularly in space missions (e.g. MUPUS). In other approaches the thermal conductivity is predicted using models requiring texture. The objective of our study was to determine the relationships between the thermal conductivity and easy measurements of strength in combination with water content or air-filled porosity. The study was performed on terrestrial porous silt loam at various soil moisture content and bulk densities. Penetration resistance measurements were taken to determine strength of the silt loam. Cores were sampled to determine gravimetric soil water contents and bulk densities that were used to calculate air-filled porosity. The data were analyzed using of the program Statistica 6. Parameters of non-linear regression equation were determined using a procedure of Fixed Nonlinear Regression. The regression equations relating the thermal conductivity with penetration resistance and air-filled porosity had a greater statistical significance (R^2 = 0.94) than those relating the thermal conductivity with penetration resistance and volumetric water content (R^2= 0.77). The accuracy of the prediction was only slightly altered when root square transformed penetrometer resistance data were used. The derived equations allow for predicting the thermal conductivity of the porous terrestrial soil based on two easily measured physical quantities. To minimize the effects of spatial variability of the measured properties on the thermal conductivity, the systems for combined measurements of penetration resistance and water content at the same place will be used in further

studies.