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# The thermal conductivity of the porous soil media

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Conditions for the heat transfer in porous media constitute other processes defining evolution of forms in media. Porosity is a property commonly met on the Earth and other planetary bodies and governs evolution on different scales. Surface erosion brings aggregated structures, fractures and textures in coats, covering soils, rocks, and contributing or governing the energy balance and mass transfer. In Earth conditions these forms are affected and even impacted by processes involving live forms of the matter, like microbiological humification of soils. Physical properties and energy exchange, remain primary conditioning, however.

Modeling the thermal conductivity and other properties defining the heat transfer in relations to mineral and organic compounds, and the phase state of matters involved, is undertaken for the porous media in the paper. The temperature is an effect of the heat transfer, but is also a condition for other physical, chemical and biological processes. Therefore, the modeling has to cover not only static cases but also the thermal inertia under thermally varying environmental conditions.

The essential goal of this work, is to link thermal modeling to the characteristic of porosity in commonly met soil media with mineral and organic compounds, by means of the physical-statistical model proposed and developed by B. Usowicz. Input data for the model, are taken for typical soil types, given by tables and literature. They cover granulometric compounds, organic matter, liquid water, water vapor and air, mass density, gas pressure. The output products of the model comprise the thermal

conductivity and diffusivity. The model was checked for a wide range of soils known on the Earth.

It was concluded, that the thermal conductivity in porous media, much depends on the aggregation scale, and the atmospheric gas pressure, being very much lower than the property of a corresponding bulk matter. A large characteristic dimension of essential aggregates in porous medium, brings a large decrease in the conductivity values. The mass density of the compound matter in bulk, and even the volumetric water contents in low amount value, means less for the conductivity than the grade of combustion and the size of aggregates. Lowly combusted or loose matter is low conductive thermally. The conductivity is non-linearly dependent on the water content and the bulk density. Usually, the conductivity of different layers, compound of the same material, more depends on depth and the grade of combustion than on circulating water, if that doesn't reach yet saturation.

The other conclusion was that a specific thermal signature of the dominating compound matter, exists however. The slope of the conductivity is low sensitive on low water content values, corresponding to the bound of water with soil grains, and - is high for large water content, corresponding to the liquid water driven by the water potential through the volume. That slope for large water content covers also the dependence on the conductivity specific to the matter compound. Several cases have been analyzed for diversity of the soil types. It occurred that the behavior of the conductivity versus the water content is different for the conductivity and the diffusivity. The last conclusion was not obvious to explain on other way than modeling but agrees quite well to experimental results. The proposed model proved its usefulness for studying thermal properties versus mineral and organic matter content. The model accounts porosity defined by the statistical volumetric measure.

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