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Measurement of soil and rock fractural hydraulic conductivities using falling head infiltration experiment of single-ring permeameter

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Abstract: Southwest China Karst is a fragile area for ecological system because of thin soil and underlying rock fracures. Soil and rock fractural hydraulic conductivities in this area determine infiltration, runoff and water retaining in soil and rock fractures for plant utilization. Determination of soil and rock fractural hydraulic conductivities is very tough due to strong heterogeneous. In this paper, we designed a single-ring permeameter to measure the hydraulic conductivities based on falling head infiltration experiment. The experiments were conducted in two karst areas in southwest China: a hillslope in Huanjiang County, northwest Guangxi for measuring soil hydraulic conductivities and a profile at the small catchment of Chenqi in the Puding basin of Guizhou for measuring fractural hydraulic conductivities. The results show that surface soil hydraulic conductivity is 2.386×10-4 m/s, much larger than 2.004×10-5 m/s for the soil at 30cm depth. Soil hydraulic conductivities are generally increased from the bottom to the top along the hillslope, and this increase is particularly significant for the soil at 30cm depth.

The fractural hydraulic conductivities were determined for the limestone profile with three fractures crossing in vertical and horizontal directions. The effective fractural aperture was determined according to calibration of water head variations of the ponded water in the single ring permeameter, which can be simulated by a numerical model based on Navier-Stokes equations and measured with an automatic observation equipment. The hydraulic conductivities were then estimated in terms of the cubic law equation. The estimated effective fractural aperture is 0.25mm for the horizontal fracture, and 0.25 and 0.5mm for the two vertical fractures crossing the horizontal in the right and left sides, respectively. The corresponding hydraulic conductivity is 0.051 m/s for the horizontal fracture and 0.051 and 0.204m/s for the two vertical fractures in the right and left sides, respectively.

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