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Saturated and unsaturated hydraulic conductivity and water retention of weathered granitic bedrock

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For the first step toward clarifying the physical processes of water movement in bedrock, hydraulic properties of weathered granitic bedrock were determined in the laboratory. Three trimmed samples (called A, B, and C in order of size) were derived from a column of weathered granite sampled in central Japan. Silicone rubber was used to fill space between each bedrock sample and the surrounding cylinder, which ensured accurate measurement of hydraulic properties of the samples. Constant head tests were conducted for the sample A and B, and a falling head test for C. All bedrock samples had very similar saturated hydraulic conductivity values of 1×10^{-4} cm s^{-1}, and the saturated water flow occurring in all samples obeyed Darcy's law. Unsaturated hydraulic conductivity and water retention functions of the sample A were determined by a step-wise outflow experiment. Parameters in both functions were optimized by comparing the observed versus computed cumulative outflow. The resultant computed cumulative outflow with optimized parameters showed a very good match to the observed cumulative outflow, indicating that Richards equation can successfully describe the unsaturated water flow during the experiment. Moreover, the derived water retention function matched well the water retention curve measured by the pressure plate method. Thus the methods proposed in this study were very effective to determine hydraulic properties of weathered bedrock. The water retention curve exhibited small change in volumetric water content throughout the measured range of $\psi >$ -200 cmH_2O. The unsaturated hydraulic conductivity function showed small decrease in hydraulic conductivity in the very wet range of $\psi >$ -30 cmH_2O, and then declined gradually with decreasing pressure head. These results indicate that the bedrock underlying the study site contains few fractures and that preferential flow in fractures is not the dominant water movement process in the bedrock.