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The estimation of recharge and the roles of the weathered layers and fractures in hard-rock aquifers assessed by a finite-difference model

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Understanding the hydrogeological functioning of hard-rock aquifers and estimating their exploitable resources still present important challenges. Three crucial conceptual questions raised by studying such aquifers will be addressed here: (i) what is their recharge? (ii) Can one demonstrate that the weathered layer is less conductive and more capacitive than the fissured one? (iii) What is the hydrogeological role of sub-vertical fractures? Based on a large and exceptionally dense data set on the Plancoët migmatitic aquifer (25 piezometers surveyed over an eight-year period in north-west Brittany, France), a finite difference twolayer model of this aquifer was built. The model geometry was based on the estimated thickness of the weathered and fissured layers and on the location of geological heterogeneities. For the purpose of detailed sensitivity analysis and to complete the usage of the head deviation variance, a new quality-of-fit criterion called “advar”, based on the seasonal piezometric amplitude variation, was developed. Recharge, estimated with a lumped hydrological model, was shown with the hydrogeological transient modeling to be a very sensitive parameter and to be close to 80% of effective rainfall. Furthermore, the two-layer model with a higher specific yield in the weathered superficial layer than in the fissured one leads to a better calibration than a single-layer model. Finally, the fractured zones were shown to present very low hydraulic conductivities compared to the rock matrix at the modeling scale, probably due to the clogging of the fractures as a result of the

weathering processes.