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PRINCIPLE OF MULTISCALE VIRTUAL POWER APPLIED TO MULTIPHASE POROUS MEDIUM

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Abstract. The governing equations are required to characterize the behavior of multiphase porous media. These equations consist of the equilibrium and constitutive equations. Under the assumption that there are no phase changes, the former must be written for each phase and are currently well-established. The latter, on the other hand, are difficult to provide, being generally applied phenomenological considerations whose parameters can be obtained from experimental data. But it is also possible to obtain the constitutive equations by applying homogenization techniques, among which is the multi-scale model based on the concept of Representative Volume Element (RVE). In this work, this kind of model is proposed for the analysis of multiphase porous media by applying the Principle of Multiscale Virtual Power (PMVP) to the strain power given by the general theory of poromechanics with the novel contribution of extending it to the case of multiple fluid phases. The PMVP, together with suitable admissible constraints on the microscale displacements and pore pressures, provides a well-established variational framework that allows linking the micro- and macro-scale and from which the micro-scale equilibrium equations and homogenization relations between the relevant macro- and micro-scale quantities are derived with straightforward variational arguments. It will be shown how the fluctuation variables affect the multiple tangent operators involved in the multi-scale problem for the multiphase porous medium. Finally, both scales are spatially discretized by the Galerkin method for numerical implementation through the finite element squared (FE2) methodology.