Preface

The main objective of this monograph is to provide a comprehensive picture of the Variational Macroscopic Theory of Porous Media (VMTPM), a general two-phase variational continuum theory with microstructure which we have been developing since 2013, based on a previous theory originally proposed in 2011. Therefore, this book contains a detailed derivation of VMTPM based on canonical arguments of variational continuum mechanics, followed by the presentation of several applications to consolidation problems we believe to be of relevance in both geomechanics and biomechanics. The intent is to show the variational consistency of this theory and to exemplify its capability to describe a large class of linear and nonlinear mechanical behaviors observed in two-phase saturated materials.

During these years, VMTPM was consolidated in the theoretical fundamentals and corroborated with studies showing its capability of predicting established experimental evidences as well as of encompassing paradigms of widespread use in multiphase poroelasticity applied to geomechanics and biomechanics, such as Terzaghi's stress partitioning principle and Biot's equations. Most of the results produced by this research have been published on specialized journals and presented at international meetings in the field. Nevertheless, we believe that the monograph format provides the ideal ground to report a revisited exposition of this variational theory keeping uniformity of treatment and of notation.

In this contribution, we strove to provide a theoretical approach capable of attaining a *medium-independent* framework, presenting to the poroelasticity community a set of equations which *any other continuum theory of poroelasticity should be downward compatible to*. This is indeed rather an ambitious plan, since it requires a general enough statement of the variational model, as well as a due discussion of a number of limit cases which should be consistently embraced by any candidate general medium-independent theory of this alleged kind. Accordingly, to achieve generality, the variational theory is developed in this work proceeding from a finite kinematic description. Just to mention a few of the limit cases specifically addressed here, it is shown that VMTPM is downward compatible to single-continuum elasticity when porosity achieves zero or unity limit conditions; special care was also taken in showing that the kinematics and the mechanics of VMTPM consistently include the description of fluid flow outside of a porous body, and consistently address the presence of free solid-fluid surfaces. A discussion is also included on the extent to which the equations of this theory apply, beyond the purely mechanical context, to media with inelastic dissipative behavior, such as in elastoplasticity. Hence, the monograph format provided a wider editorial template suitable to accommodate this more extended treatment.

This work was written for an intended audience including investigators in the fields of continuum mechanics, geomechanics and biomechanics, as they will find in this contribution not only a thorough presentation of VMTPM as a theoretical framework for porous media, but also several of its applications of relevance for their research.

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