FINITE ELEMENT ANALYSIS OF MECHANICAL DEFORMATION PROCESSES IN SEDIMENTARY BASINS

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ABSTRACT

The study of sedimentary basins is an important issue in the field of geophysics and geomechanics that seeks understanding the geological history and reconstructing the poromechanical history of many regions of the planet. The purpose of this work is to study the mechanical behavior of sedimentary basins through tridimensional numerical simulations of different fundamental processes involved in its formation, such as sediment deposition, gravitational compaction and tectonic-driven deformation. The process of mechanical compaction of a sedimentary basin in fully saturated conditions takes place through water expulsion from the porous material, thus resulting in grain repacking and volume reduction. In absence of tectonic-driven deformation, a deposited sedimentary layer compacts as the excess pore-pressure generated by its own weight dissipates progressively [1]. Nevertheless, tectonic movements play an important role in the mechanical deformation of basins, accelerating or slowing down its compaction process [2]. One of the major difficulties involving this kind of simulation is connected with the occurrence of large change in porosity throughout the compaction process. The coupled nature of the deformation problem may be understood as follows: large strains modify the microstructure, which leads to a change in the poromechanical properties of the sediment material and thus affecting the basins response. This behavior requires that the poromechanical constitutive law be formulated in the framework of finite irreversible strains, so the key components for the model are the hydro-mechanical and elasticity–plasticity couplings [3]. The numerical simulations are performed through the finite element method with a shared memory multiprocessing interface. The simulations are performed on a prismatic rectangular mesh which is intended to represent an offshore sea bed where accumulation of a thick sedimentary layer occurs over tens of millions of years. After this long period of deposition and compaction of sediments under gravitational forces and excess pore-pressure dissipation, extensional and compressive tectonic movements are applied on the sides of the basin. Some important points of the theoretical and numerical models are described as well as a comparative analysis of the compaction process with and without tectonics influence.

Key words: Sedimentary Basin, Finite Poroplasticity, Gravitational Compaction, Tectonics

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