Fluid filtration and sediment compaction dynamic under a condition of local gas hydrate accumulation

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Accumulation of saturated sediments during geological time leads to their compaction and corresponding flow of interstitial fluid. Within the framework of the general mathematical model developed under assumption of visco-elastic rheology of sediments, these interrelated processes are described by a nonlinear system of coupled partial differential equations and are analyzed using numerical simulation in terms of the model including compaction of depositing sediments and movement of pore fluids in course of sedimentation. The set of model calculations demonstrated how the rheological state of sediments and sedimentation rate affected the fluid pressure and flow and how the rate of sediment compaction depended on hydrodynamic regime of fluid flow. The solution obtained satisfactorily simulates the coupled geological process of compaction and pore fluid flow in sedimentary basins and makes it possible to vary the problem parameters and determine the porosity and pore pressure evolution, and fluid flow velocities for particular geological conditions of sedimentation. It is shown that the non-linear complex of parameters determined the pore pressure in course of sedimentation and compaction. It is shown how the rate of hydrate forming and free porosity decreasing in the hydrate stability zone depend on pore fluid filtration rate, which itself depends on sedimentation rate and sediments and fluid physical property. It is recognized also as hydrate accumulation acts on compaction, porosity loss and pore fluid velocity in shallow zones of sediment column. Interdependence of these processes is shown analytically and numerically.