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A comparison/validation of a fractional derivative model with an empirical model of non-linear shock waves in swelling shales

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Control of drilling parameters, as fluid pressure, mud weight, salt concentration is essential to avoid instabilities when drilling through shale sections. To investigate shale deformation, fundamental for deep oil drilling and hydraulic fracturing for gas extraction ("fracking"), a non-linear model of mechanic and chemo-poroelastic interactions among fluid, solute and the solid matrix is here
discussed. The two equations of this model describe the isothermal evolution of fluid pressure and solute density in a fluid saturated porous rock. Their solutions are quick non-linear Burger's solitary
waves, potentially destructive for deep operations. In such analysis the effect of diffusion, that can play a particular role in fracking, is investigated. Then, following Civan (1998), both diffusive and shock waves are applied to fine particles filtration due to such quick transients , their effect on the adjacent rocks and the resulting time-delayed evolution. Notice how time delays in simple porous media dynamics have recently been analyzed using a fractional derivative approach. To make a tentative comparison of these two deeply different methods,in our model we insert fractional time derivatives, i.e. a kind of time-average of the fluid-rocks interactions. Then the delaying effects of fine particles filtration is compared with fractional model time delays. All this can be seen as an empirical check of these fractional models.