# Porous Compaction in Transient Creep Regime and Implications for Melt and Petroleum Extraction

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Liquid segregation through a porous medium depends on the ability of the matrix to deform and compact. Earth's materials have a complex rheology, in which the balance between the elastic and viscous contribution to the deformation is time-dependent. We propose a Burger-type model to investigate the implications of transient rheology for viscous compaction of a porous material. The model is characterized by three dimensionless parameters: (1) the Deborah number, De, defined as the ratio of an elastic time scale over the compaction time scale, (2) the ratio of the transient and steady viscosities, $\lambda_\mu$, and (3) the ratio of the transient and steady rigidity moduli, $\lambda_G$. For De$<10^{-2}$ the compaction occurs in the classical viscous mode and solitary waves (magmons) are generated. For larger De, compaction is mainly controlled by $\lambda_\mu$. For small transient viscosity, compaction occurs in an elastic mode and shock waves are generated. For increasing $\lambda_\mu$, two new regimes are observed, first "shaggy" shock waves and then "polytons". Shaggy shock waves are characterized by the presence of secondary peaks at the wave propagation front. The length-scale of the peaks is a decreasing function of $\lambda_G$ and their amplitude decreases along the propagation. In the polytons regime, the peaks tend to detach and mimic the behavior of solitary waves. Polytons and shaggy shock waves are expected both in the mantle and in sedimentary basins. Polytons will require a particular attention as they imply larger extraction velocities and smaller compaction length-scales than the usual magmons.

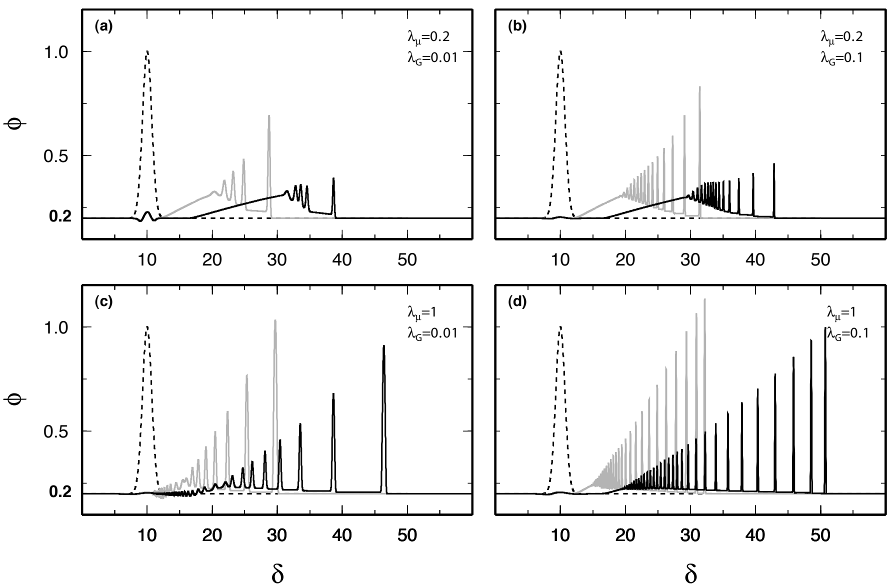


Figure 1: Evolution of porosity for a viscoelastic Burger's with a large Deborah number De=0.5, and for different values of viscosity ratio $\lambda_\mu$ and rigidity modulus ratio $\lambda_G$. The curves are shown for $t$=0 (dashed line), $t$=1.5 (thin grey line) and $t$=3 (black line). A shock wave is formed and then evolves into a train of peaks of small length scale and large amplitude, or "polytons".