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Effective viscoelastic properties of shales.

Jan Cornet (1), Marcin Dabrowski (1,2), and Daniel Schmid (1)
(1) UIO, PGP, Oslo, Norway (jscornet@hotmail.fr), (2) Polski Institute Geologiczny, Wroclaw, Poland

Shales are often characterized as being elasto-plastic: they deform elastically for stresses below a certain yield and plastically at the limit. This approach dismisses any time dependent behavior that occurs in nature. Our goal is to better understand this time dependency by considering the visco-elastic behavior of shales before plasticity is reached. Shales are also typically heterogeneous and the question arises as to how to derive their effective properties in order to model them as a homogeneous medium. We model shales using inclusion based models due to their versatility and their ability to represent the microstructure. The inclusions represent competent quartz or calcite grains which are set in a viscous matrix made of clay minerals.
Our approach relies on both numerical and analytical results in two dimension and we use them to cross check each other. The numerical results are obtained using MILAMIN, a fast-finite element solver for large problems, while the analytical solutions are based on the correspondence principle of linear viscoelasticity. This principle allows us to use the results on effective properties already derived for elastic bodies and to adapt them to viscoelastic bodies. We start by revisiting the problem of a single inclusion in an infinite medium and then move on to consider many inclusions.