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Decorrelation of poroelastic data

Bianca Kretz (1), Willi Freeden (2), and Volker Michel (1)

(1) University of Siegen, Department of Mathematics, Germany, (2) CBM GmbH, Bexbach, Germany

Poroelasticity is an important aspect to consider in geothermal research. It is a part of material research and describes the interaction between solids deformation and the fluid flow. The mathematical model and equations to describe this behaviour are dated back to Biot in the 1930s. Since we are interested in aquifers in geothermal research, this aspect is one choice to connect the behaviour between the solid and the fluid phase.

The quasistatic equations of poroelasticity (QEP) in dimensionless form with the unknown terms u (displacement) and p (pore pressure) are the following partial differential equations:

$$-\frac{\lambda+\mu}{\mu}\nabla_x(\nabla_x \cdot u) - \nabla_x^2 u + \alpha\nabla_x p = f,$$

$$\partial_t(c_0\mu p + \alpha(\nabla_x \cdot u)) - \nabla_x^2 p = h,$$

Fundamental solutions -which we need for our approach- were derived for example by [4] for the non-dimensionless case and for the dimensionless (homogeneous) case by [1].

The background and main reason of our approach is to get detailed structures and information of our unknown variables. In a first step we approximate a geothermal deformation field by given data and in a second step decorrelate this approximation to get several detail structures. To make use of the fundamental solutions, we have to regularize them (since they have singularities) by using a parameter τ (called scale or scaling parameter) with the help of a Taylor approximation similar to [2,3]. Wavelets are constructed by subtracting two regularized fundamental solutions with a different scale.

The aim is to convolve given data u and p e.g. from the method of fundamental solutions (cf. [1]) with the wavelets in order to decorrelate these data and extract more details of u and p. Another way to do can be to approximate given data with these regularized fundamental solutions. We show some theoretical properties of the regularized fundamental solutions and results of first numerical tests.

References

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