



Viscoelastic Anisotropic Constitutive Law for Rock Shales based on Laboratory Creep Experiments

Maciej Trzeciak (1), Hiroki Sone (2), and Marcin Dabrowski (1)

(1) Polish Geological Institute, Wroclaw, Poland, (2) University of Wisconsin, Madison, USA

In situ stress prediction is critical for successful hydraulic fracturing and later exploitation of an unconventional shale gas/oil reservoir. In order to provide stress models during and after fracturing a reliable stress-strain constitutive law is needed. The most popular models used in the petroleum industry take into account only elastic constitutive laws, which have the assumption of no energy dissipation. As was shown by several authors (e.g. Warpinsky 1986, Gunzburger&Cornet 2007, Sone&Zoback 2013, 2014) viscoelastic creep strain and stress relaxation reach significant amounts in rock shales and should be considered in stress modeling.

Viscoelastic functions needed for the constitutive law were obtained during creep experiments on horizontal and vertical shale plugs. We were not in the possession of samples cut at 45° to bedding, and because of that the constitutive relation is limited to the normal strains and stresses. During experiments two creep functions, $C_h(t)$ and $C_v(t)$, and two hereditary Poisson's ratio functions $v_{12}(t)$ and $v_{13}(t)$ were measured.

In this paper we present laboratory procedures for creep tests, basic theory of anisotropic (vertical transverse isotropy) viscoelastic constitutive modeling and a simple model of stress relaxation after application of constant strain.