

## **Oil shales: Their shear story**

*Jyoti Behura: Center for Wave Phenomena, Geophysics Dept.; , Mike Batzle, Ronny Hofmann, Center for Rock Abuse, Geophysics Dept.; John Dorgan: Chemical Engineering Dept., Colorado School of Mines, Golden CO*

Organic-rich shale houses large untapped amounts of hydrocarbons. In-situ recovery of these hydrocarbons involves thermal cracking and steam flooding of these reservoirs which changes rock physical properties, and shear properties in particular. We measured, within the seismic band, the complex shear modulus (and thus also the attenuation) of two oil shale samples, one rich in organic content and the other low in organic content.

Both the kerogen-rich and the lean shale show a weak dependence of modulus and  $Q$  on frequency. Their properties can be effectively considered frequency independent within the seismic band. These shales, however, show a dramatic change in shear-wave velocity and attenuation with temperature. Their shear moduli and  $Q$  decrease with melting of the kerogen, but with the subsequent loss of some of the kerogen, both shear moduli and  $Q$  increase. The magnitudes of these changes along the direction of the bedding and perpendicular to the bedding differ, which makes velocity anisotropy and attenuation anisotropy potentially valuable attributes. The velocity anisotropy and attenuation anisotropy of the shales can change significantly with temperature, in some cases by more than an order of magnitude. The amount of kerogen content in shale also influences the velocity and attenuation.

The more the organic content, the lower is the shear modulus and the higher is the attenuation.