# Physical Source of the Dispersion

The presence of the liquid is resulting in an increase of the shear modulus, even though the liquid shear modulus is zero. Why is that so? The reason is that in an inhomogeneous medium, when we apply stress or strain at the macroscopic scale, that stress or strain gets resolved locally in a complicated way because of the inhomogeneities. It is very easy to see that this must be so in a granular medium, but is clearly true also in any inhomogeneous medium. An applied external compression can be resolved locally into a shear field. An applied external shear can be resolved locally into a compressional field.

# Physical Source of the Dispersion (2)

This is the physical source of the effect. If we apply an external shear to a medium containing liquid, it matters that the liquid is present and not replaced by air. It matters because the external shear can be resolved into local compression in some regions containing the liquid. In these regions, the liquid can support the compression (but not a shear), and therefore the liquid stores some of the energy applied to the system by the external shearing force.

## Physical Source of the Dispersion (3)

This discussion shows qualitatively why the effective medium theory predicts that the shear modulus depends on the bulk modulus of the liquid. On the other hand, if the liquid has enough time (and a finite — nonzero — permeability permits it) to move out of the way, it can relax to a state that does not support any of the local compression, and then we have Gassmann's result. So time scale and permeability are important, and ultimately it is permeability that controls this dispersive effect in poroelastic systems.