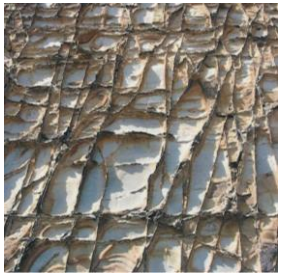
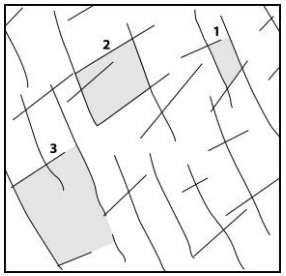
ARE GEOPHYSICISTS LOOKING FOR THE MOST PRODUCTIVE FRACTURES WHEN INTERPRETING SHEAR WAVE SPLITTING?

Nick Barton, Oslo, Norway

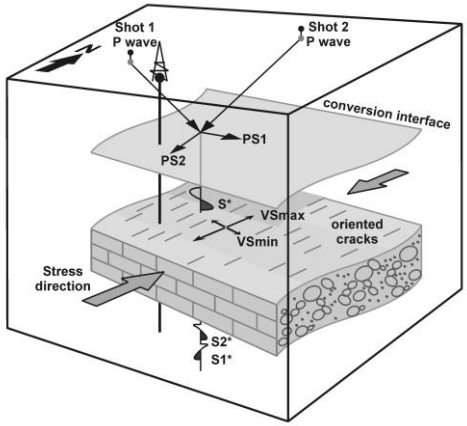




A rock mass often has several joint sets – which can be hindrances or pathways for flow. Barton, 2006.

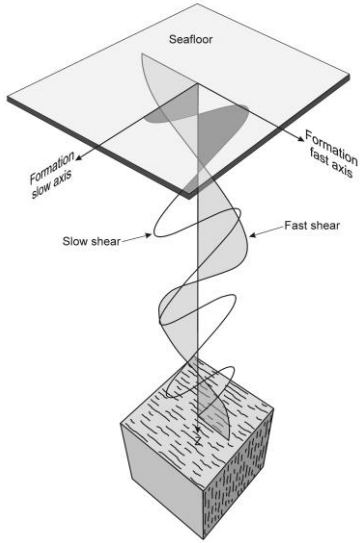
Open fractures or microcracks are traditionally assumed to be *//* to σ_H max, and the fast shear wave V_S max is assumed to follow this trend too.

Is this the rule or an anomaly? (Because joints under shear stress should be much better conductors!)

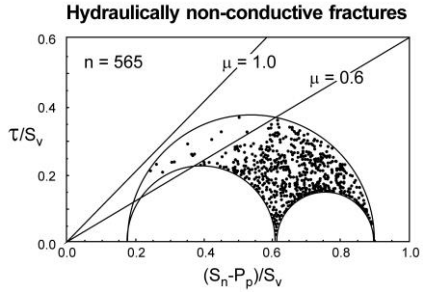


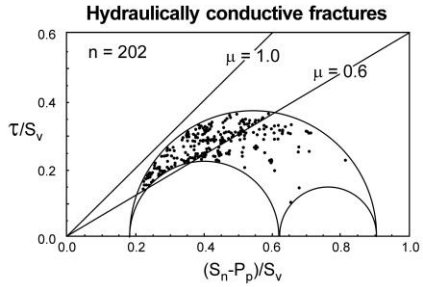
Far-offset VSP using PS waves to interpret the presence of fractures and aligned stress. Stenin et al., 2002).

Note that even σ_h min may be tens of MPa and may close fractures in weaker reservoir rocks.

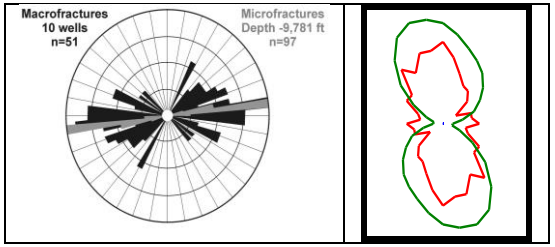


Barkved et al. 2004. ***One set of fractures?***
Or two sets intersected by σ_H max?



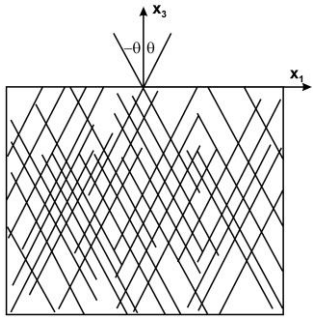


The joints under shear stress are the best conductors in the case of hard crystalline rocks.*Colleen Barton, Zoback, Townend, et al. 1995, 2000.*



*East Texas well data (Laubach et al. 2000), and 'deviated' (from 'N-S' major stress) water-flood data from numerous well pairs, from Heffer, 2002 and Zhang et al. 2007. C****onjugate pairs with dominance of one set****?*

It may be reasonable to assume that the micro-cracks are *//* to σ_H max. So many of the fracture sets may be bisected by σ_H max. There are numerous sets of data showing deviation of V_S max, and of max. permeability, from the σ_H max azimuth.



Shear-wave splitting when the incident waves are no longer split by vertical fracturing. Sayers, 2002.The conjugate pair of dipping fracture sets are typical of domal / anticlinal reservoirs. (Ekofisk, Valhall).

Here the shear wave components qS_1 and qS_2 depend on *both* the shear *and* normal compliances, since the incident angles are no longer parallel to the fractures.

The fast shear wave may be interpreted, conventionally, as parallel to a single set of fractures, *when the reality is that it is composed of two fracture-set components.* Here is the possibility of transient 4D phenomena (rotating anisotropy, attenuation axes), since the two sets are different.