Geophysical Research Abstracts
Vol. 18, EGU2016-8176-1, 2016
EGU General Assembly 2016

Determining the frequency dependence of elastic properties of fractured rocks

Benedikt Ahrens and Jörg Renner

Institute of Geology, Mineralogy and Geophysics, Ruhr-Universität Bochum, Bochum, Germany (benedikt.ahrens@rub.de, joerg.renner@rub.de)

In the brittle crust, rocks often contain joints or faults on various length scales that have a profound effect on fluid flow and heat transport, as well as on the elastic properties of rocks. Improving the understanding of the effect of fractures and the role of stress state and heterogeneity along the fractures on elastic properties of rocks is potentially important for the characterization of deep geothermal reservoirs. Seismic surveys, typically covering a frequency range of about 1 to 1000 Hz, are a valuable tool to investigate fractured rocks but the extraction of fracture properties remains difficult. The elementary frequency-dependent interaction between fractured rock matrix and viscous pore fluids and the resulting effects on wave propagation require well-founded dispersion analyses of heterogeneous rocks. In this laboratory study, we investigate the stress dependence of the effective elastic properties of fractured reservoir rocks over a broad frequency range. To assess the effect of faults on the effective elastic properties, we performed cyclic axial loading tests on intact and fractured samples of Solnhofen limestone and Padang granodiorite. The samples contained an idealized fault, which was created by stacking two sample discs on top of each other that experienced various surface treatments to vary their roughness. The dynamic loading tests were conducted with frequencies up to 10 Hz and amplitudes reaching 10% of the statically applied stress. Simultaneously, P- and S-wave measurements were performed in the ultrasonic frequency range (above 100 kHz) with a total of 16 sensors, whose positioning above and below the samples guarantees a wide range of transmission and reflection angles. Preliminary results of static and dynamic elastic properties of intact Padang granodiorite show a pronounced increase in Young's moduli and Poisson's ratio with increasing axial stress. Stress relaxation is accompanied by a decrease of the modulus and the Poisson's ratio. The pressure sensitivity of the elastic parameters reduces with increasing normal stress, likely reflecting the successive closure of pre-existent microcracks. At constant strain, both parameters exhibit a small frequency-dependent increase (in the frequency range from 10^{-2} to 10^{0} Hz). This trend is consistently continued by the ultrasonic measurements (>100 kHz) that yield the highest moduli. Further investigations will focus on the effect of faults on the stress and frequency dependence of the elastic properties. The chosen ultrasonic sensor arrangement will allow us to characterize the fault state by calculating transmission and reflection coefficients and their dependence on incident angle.