ICNEM
International Conference on Nonlinear Elasticity in Materials

Contribution ID: **23** Type: **not specified**

Dynamic Acousto-Elastic Testing of Intact and Fractured Westerly Granite

Monday 14 July 2025 10:50 (35 minutes)

Nonlinear elastic effects are ubiquitous in the Earth's crust, often revealed by small temporal changes in seismic wave velocity. Being able to interpret these subtle changes is critical to help us assess the state of stress and associated seismic risk. The objective of this work is to unravel the physical mechanisms responsible for the nonlinear elastic response of rocks, and in particular to better understand the role of macroscopic fractures. We perform Dynamic Acousto-Elastic Testing on cylindrical samples of Westerly granite, either intact or with a mated fracture perpendicular to the long-axis. We apply axial and confining stress oscillations of amplitude ±0.5 MPa and 2 min-pump period (frequency f0 ≈ 0.083 Hz), and probe the sample along its long-axis with S-wave, 500-kHz transducers. The quasi-static axial stress is also varied stepwise, between 1 and 17 MPa, both upward then downward, while the confining pressure is kept constant (4 MPa). Dynamic oscillations are conducted at each stress step, and the timing between each oscillation and stress steps is precisely controlled. Each experiment lasts approximately 12 hours. We extract two nonlinear elastic parameters for the received S-wave, as well as for a converted P-wave: R0, the average wave speed change induced by the oscillation, and R1, the wave speed change taking place at the pump frequency f0. The observations for the P-wave and S-waves are similar, with the difference that results for the low-amplitude converted P-wave are noisier. Our preliminary results indicate that counterintuitively, and consistent with a previous study, R1 is smaller for the fractured sample. We also find that R0 is positive (average stiffening) for oscillations taking place when the axial stress is stepped up, and negative (average softening) during down steps. Moreover, this effect is more pronounced for the fractured samples, that is, R0 is larger in absolute value for fractured samples. These results are discussed in the context of previous measurements conducted on fractured rocks.

Primary authors: KLINGHAMMER, Hermann (Pennsylvania State University); RIVIERE, Jacques (Pennsylvania State University); ELSWORTH, Derek (Pennsylvania State University); SHOKOUHI, Parisa (Pennsylvania State University)

Presenter: RIVIERE, Jacques (Pennsylvania State University)

Session Classification: Time-dependent nonlinear effects

Track Classification: Time-dependent nonlinear effects