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Frequency-Dependent Attenuation of Elastic Waves in Fault Zones
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The period from 9/01/2018 through 8/31/2019 represents the first year of funding from the DNI program. The goals of this project are to develop a technique for measuring frequency-dependent attenuation of seismic waves in the laboratory. We plan to use this technique to evaluate whether and how high pore fluid pressures cause frequency-dependent attenuation.

This project funded one graduate student, Celine Fliedner, for 12 months. This 12-month period represented Celine's second academic year as a graduate student at Rice University. In this time, Celine worked on developing the forced oscillation technique in our triaxial deformation apparatus to measure attenuation at wave frequencies between 0.001 and 20 Hz. This included designing and ordering new strain gauge holders, measuring the frequency-dependent attenuation of calibration materials (aluminum and PMMA), and developing a workflow for signal processing and data analysis. Celine has completed all of these activities and is ready to begin measuring attenuation on rock samples over this frequency range.

In addition, Celine has begun characterizing the composition and microstructure of a sample of Pelona schist, which will be used to make the initial suite of attenuation measurements. She has measured the P- and S- wave elastic wave speed and attenuation of this sample at ultrasonic (1 MHz) frequencies, and at temperatures to 160 C and pressures to 175 MPa. These measurements serve two purposes. First, they will extend the range of frequencies over which the frequency-dependent attenuation is measured and will help us constrain the mechanisms of frequency-dependent attenuation. Second, these measurements will be analyzed with rock physics models to determine microstructural and environmental controls on seismic wave velocities in phyllosilicate-rich rocks.

In the first year of this project, Celine has presented posters of this work at the 2018 annual American Geophysical Union (AGU) meeting in Washington DC (MR31B-0088) and the GeoPrisms Theoretical and Experimental Institute meeting in San Antonio, Texas. Celine also passed her qualifying exam in August 2019, with a thesis proposal that is motivated by the results of experiments funded by this project. In the coming year, Celine will present results from this project at the 2019 annual AGU meeting, as well as the Gordon Conference on Rock Deformation.

In the coming year, I anticipate that Celine will conduct a suite of experiments to measure the frequency-dependent attenuation of the Pelona schist as a function of temperature and effective stress. She will also write up her first publication on ultrasonic velocities and attenuation are their relationship to the microstructural parameters of the schist.

An undergraduate student, Christina Stoner, has been using nanoindentation techniques to measure deformation mechanisms and micro-scale attenuation of phyllosilicates. Although Christina's wages and the research costs are not funded by this grant, Celine Fliedner has served as a mentor to Christina on this project, and her salary has been funded by this grant. Thus, this PRF- DNI grant has contributed to this project, which is also a new direction for our research group.