# Nonlinear interactions of shear waves in an elastic medium

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With many of the world's conventional oil and gas deposits already in development or within stages of exploration, it is important to look for new approaches to interpret and develop non-ideal resources. Here, on the laboratory scale, we look at the nonlinear coupling of two shear waves whose interactions provide valuable information on the microstructure (particularly cracks and their orientations) and porosity of our rock samples. By understanding these parameters, we are developing methods to characterize the permeability caused by these fractures, which is key when exploiting unconventional oil and gas plays.

We present a laboratory experiment in which a strong-signal, lower frequency shear wave pump slightly perturbs the elastic properties of our sandstone sample. These changes are sensed by a lower amplitude, high frequency shear wave probe. The two waves propagate perpendicular to one another, but with their particle motions aligned. Specifically, we are measuring the delay in the high frequency shear wave probe caused by the low frequency shear wave pump. The pump and probe signals are generated by a function generator, which is then transmitted through transducers and the results are recorded on a digital oscilloscope. The pump signal is amplified to achieve maximum perturbation; no amplification is used on the probe signal. A bandpass filter is used to reduce the amplitude of the pump, which allows a clear signal of the probe to be recorded. We observe the difference in the recorded wave interactions as a function of the orientation of cracks in the sample. This information can be used to characterize the fractures in the sample, which gives us further information on potential permeability within the sample.

Preliminary data collection has shown that this experimental design offers unique and interesting results. The probe signal shows a new oscillatory pattern in which the amplitude of the signal increases with increased voltage. Further data interpretation and collection are intended for honours studies.

Atlantic Geology, 2017, Volume 53
Geological Association of Canada – Newfoundland and Labrador Section Abstracts – 2017 Spring Technical Meeting
doi: 10.4138/atlgeol.2017.009