Numerical and experimental observation of nonlinear responses from the interaction of two progressing waves at an interface

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The nonlinear response of sedimentary rocks has been an ongoing area of research in recent years due to information it can reveal about reservoir porosity, fractures, and pore fluids. We attempt to observe numerically and physically a nonlinear response, generated at an interface between two different nonlinear media (e.g., reservoir rocks) due to the interaction of two acoustic waves at that interface, proposed theoretically by previous authors. It is thought that this response could be used in the future as a new way of mapping the reservoir properties mentioned previously. We first model two waves interacting at an interface both to see if we can observe the response numerically, and also see what parameters to use in physical experiments. The nonlinear response is demonstrated by numerical modelling and thus the project progressed to physical experiments. In the experimental aspect of the project, we use high-frequency transducers as sources for the waves with an interface made between several different nonlinear materials (e.g., gelatin, water, salt brine). Two different receiving mechanisms were explored, a vertical array of transducers identical to the sources and a Polytec laser vibrometer positioned on a motorized slider, programmed to incrementally traverse across the media. The magnitude of the response varied between different materials, as expected. We have met the objective of the project by observing this response physically, which opens up a new line of work to both characterize these waves when produced from different materials, and also to perform the experiment with sedimentary rocks for a more realistic analogue to hydrocarbon reservoirs. [Poster]

*Winner of the Canadian Society of Exploration Geophysics Award for best presentation of a geophysics-related paper

Atlantic Geology, 2018, Volume 54
Atlantic Universities Geoscience Conference 2018 – 68th Annual Conference, November 1-3, 2018
doi:10.4138/atlgeol.2018.015