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Nonlinear-nonequilibrium wave propagation in sandstones

Donatella Pasqualini[a], Jim Tencate[b] and Salman Habib[a]
[a]Los Alamos National Laboratory, POBox 1663, Los Alamos, NM 87545, USA
[b]EES-11 (Geophysics) - Los Alamos National Laboratory, MS D443, Los Alamos, NM 87545, USA

The transition from linear to nonlinear-nonequilibrium dynamical elasticity in rocks is of considerable interest in seismic wave propagation as well as in understanding the basic dynamical processes in consolidated granular materials. We have carried out a careful experimental investigation of this transition for Berea and Fontainebleau sandstones. These experiments have showed the existence of two strain regimes. At low strain (10-9 up to 10-7) the rocks behave elastically as classical (Landau-Lifshitz theory) nonlinear materials. At higher strains memory effects due to a driven nonequilibrium state complicate the characterization of the nonlinear behavior. The understanding of this second region is not trivial. The main focus of this work is to review the behavior of the low strain, nonlinear region and to report on new experiments meant to understand more about the behavior in the nonequilibrium regime.