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Three wave mixing test of hyperelasticity in sedimentary rocks

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We report measurements of 3-wave mixing amplitudes on solids whose 3rd order elastic constants have also been measured by means of the elasto-acoustic effect. Because attenuation and diffraction are important aspects of our measurement technique we analyze our results using a frequency domain version of the KZK equation, modified to accommodate an arbitrary frequency dependence to the attenuation. We find that the value of β so deduced for polymethylmethacrylate (PMMA) agrees quite well with that predicted from the stress-dependent sound speed measurements, establishing that PMMA may be considered a hyperelastic solid, in this context. The β values of sedimentary rocks, though they are typically two orders of magnitude larger than e.g. PMMA's, are still a factor 3-10 less than those predicted from the elasto-acoustic effect. Moreover, these samples exhibit significant heterogeneity on a centimeter scale, which heterogeneity is not apparent from a measurement of the position dependent sound speed.