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Applications of Acoustic Imaging to Map and Quantify Rock Deformations

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Various methods have been used to study microstructural properties of rocks. Their goals have been to relate microstructure and other lithological characteristics at least qualitatively to the velocity and attenuation properties. Traditionally, microscopic imaging techniques such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), and optical microscopy have been used to study the grains, cementation, and pore structures of rocks. These qualitative microstructural characterizations have limited application to quantitative seismic wave propagation. For example, contact stiffness, which cannot be quantified by optical and SEM methods, is known to control wave velocity and attenuation in granular media. Optically opaque kerogen material in organic rich shale governs wave velocity and anisotropy, but is a challenging problem for microstructural characterizations.

We describe the use of the non-destructive technique of Acoustic Microscopy (AM) to map and quantify microstructure in terms of elastic impedance at a pore-scale resolution. We will present examples of rock images using high resolution acoustic microscopy in the GHz frequency range and acoustic imaging in the MHz frequency range and show how the impedance microstructure of rocks can be directly measured, analyzed, and quantifyied at pore-scale resolutions.