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Grain sorting effect on seismic velocities: rock physics models for reservoir quality prediction

The most important textural features of a sandstone reservoir are grain size and sorting. Grain sorting is determined by deposition and may affect sediment bulk and elastic properties in a non-linear and non-unique way. The quantification of these relations is important for seismic reservoir characterization, especially in geological settings where sand/shale (bimodal) mixtures are present.

Laboratory measurements, theoretical models, and field data indicate that in sediments and sedimentary rocks the deterioration of grain sorting results in a more efficient packing, thus causing the framework mixture to stiffen and the velocity to increase. Sediments and rocks with a grain- or mud-supported fabric, and a low stage of textural maturity will show a high elastic velocity, in comparison with mature or supermature sediments. In contrast, if the rock framework is mechanically stable, well-sorted clastic rocks with a simple diagenesis will exhibit better reservoir properties and lower elastic velocities that poorly-sorted clastic rocks.

Here is presented a set of rock physics models that predicts the effect of textural sorting and variable composition and fabric (e.g. grain- and mud-supported fabric) on velocity and porosity. The models link porosity, mineralogy, pressure, texture, fabric, and pore fluid bulk modulus to the elastic rock properties. The theoretical relationships among seismic wave velocities, grain sorting, and composition suggested in the models can be used for theoretical mixing of sand and shale in dispersed or laminar modes and, ultimately, for seismic forward modeling and reservoir characterization in clastic rocks.