Multiscale Laboratory and Numerical Rock Physics – A Snapshot of ongoing ROCKETH-Science

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Providing a link between rock/pore fluid properties and seismic attributes is the main goal of rock physics and key for characterizing a subsurface fluid reservoir from seismic data. Identifying and understanding the physical processes in a reservoir rock at different scales is the first step and the subject of our research. We (Quintal et al., 2011) show that combining laboratory and numerical experiments is a powerful tool to achieve an unbiased comprehension of rock physical processes. While in laboratory experiments it is very difficult to control all the physical processes, in numerical experiments all physical parameters can be controlled exactly. Numerically, it is even possible to study different physical processes separately from each other, which otherwise coexist in nature or in the laboratory.

A knowledge-feedback between laboratory and numerical studies is demonstrated on two examples of current rock physics challenges: (i) understanding the influence of the rock microstructure on effective elastic properties and (ii) identifying the dominant physical mechanism responsible for intrinsic attenuation in saturated rocks at seismic frequencies. Both presented challenges are subject to ongoing research conducted in The Rock Physics Network at ETH Zurich (ROCKETH; www.rockphysics.ethz.ch).

In addition, the latest ultra-high-resolution 3D digital images of rock microstructures, obtained by Synchrotron radiation X-ray tomographic microscopy, are presented (Madonna et al., 2013). We describe this method and, to demonstrate its wide applicability, present 3D images of very different rock types: sandstones, dolomite, and three-phase magmas. For some samples, full and partial saturation scenarios are considered using oil, water, and air. The rock images precisely reveal the 3D rock microstructure, the pore space morphology, and the interfaces between fluids saturating the same pore. We also discuss and suggest possible applications and research directions that can be pursued on the basis of our data.

References

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