Numerical support of laboratory experiments: Attenuation and velocity estimations

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We show that numerical support of laboratory experiments can significantly increase the understanding and interpretation of the obtained results. First we perform simulations of the Seismic Wave Attenuation Module (Figure 1) to measure seismic attenuation of reservoir rocks. Our findings confirm the accuracy of this system. However, precision can be improved by optimizing the sensor positions (Figure 2). Second we model wave propagation for an ultrasonic pulse transmission experiment that is used to determine pressure- and temperature-dependent seismic velocities in the rock. Multiple waves are identified in our computer experiment, including bar waves. The metal jacket that houses the sample assembly needs to be taken into account for a proper estimation of the ultrasonic velocities (Figure 3). This influence is frequency-dependent.

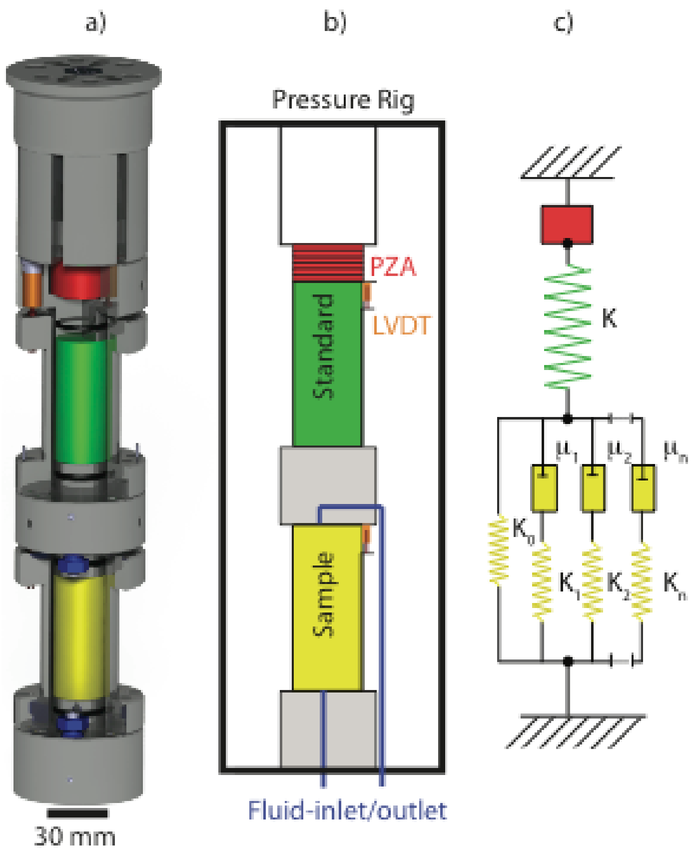

Figure 1. Schematic cross-section of the ETH-developed SWAM (Madonna et al. 2011). a) CAD drawing, b) Sketched construction, c) Physical model.

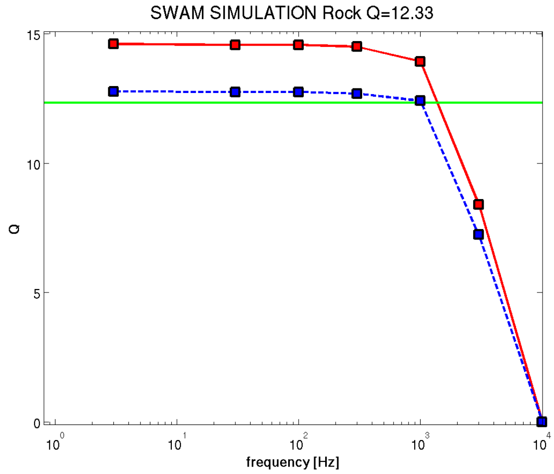

Figure 2. Results of the SWAM computer experiments for a Rock sample with an attenuation of Q=12.33 (green line) for a range of applied excitation frequencies. Q_{real} (red solid line) can be compared with the real experimental setup. An optimized sensor positioning allow for more accurate measurements of Q (Q_{opt}; dashed blue line).

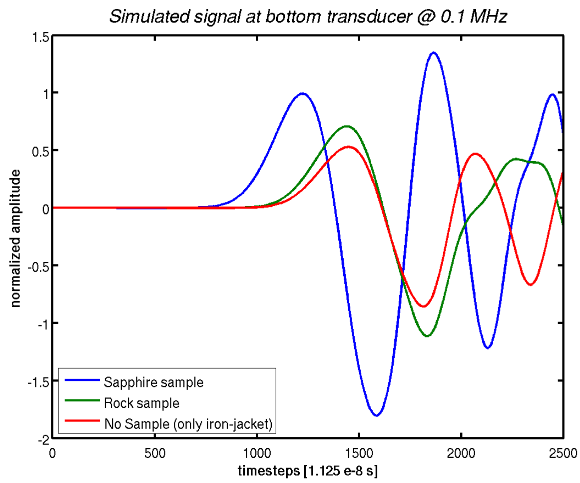

Figure 3. Simulated vertical displacement at bottom transducer of the sample assembly for ultrasonic velocity measurements in the Paterson gas-medium apparatus (Burlini et al., 2005). The reference signal (blue line) using a Sapphire sample arrives first. The time delay of the signal for the rock sample (green line) is normally used to estimate the velocity of the rock. However, the signal with no sample (red line; wave propagation through the iron jacket only) may disturb the signal for the rock.

REFERENCES

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