Tomographic Imaging of Thermally Induced Fractures in Granite using Bayesian Inversion

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Velocity, attenuation, and enhanced velocity tomography images of a Lac Du Bonnet granite sample subjected to six heating cycles are presented. The results were obtained by Bayesian inversion of acoustic data with genetic algorithm optimization method. The highest possible spatial resolution of images was achived by using the multiscale inversion technique enhanced.

Both velocity and enhanced velocity tomography accurately imaged changes in the rock micro-structure caused by thermal stresses however, enhanced velocity tomography gave a much better spatial resolution. Attenuation tomography based on inversion of pulse rise times was able to image only a rough structure of the sample and it has a problem with reasonable imaging of the crack formed in the sixth heating cycle.

The internal structure of rock samples studied in laboratory experiments can be described by a variety of physical parameters. Some of them, like the velocity of acoustic waves, enhanced velocity or quality factor can be reconstructed by means of ultrasonic tomography. In this talk I present the results of classical velocity tomography imaging, accompanied by the results of attenuation tomography and recently introduced enhanced velocity tomography obtained for a Lac Du Bonnet granite sample subjected to thermal stresses. To invert acoustic data recorded during six heating cycles, a Bayesian inversion scheme accompanied by a genetic algorithm optimization approach and the robust Cauchy norm have been used. To obtain the highest possible spatial resolution of images the inversion was performed in two steps. In the first step a crude parametrization of the sample was used. The result of this stage were next taken as an a priori model for a final inversion with refined parametrization.

Both velocity and enhanced velocity tomography accurately imaged changes in the rock micro-structure caused by thermal stresses. However, enhanced velocity tomography gave a much better spatial resolution than velocity tomography. On the other hand, attenuation tomography based on inversion of pulse rise times was able to image only a rough structure of the sample and it has a problem with reasonable imaging of the crack formed in the sixth heating cycle.