Thermal microcracking in rock

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With this project, we propose a systematic experimental study of thermal cracking in rock. Damage will be monitored in real time in rock samples not only with acoustic emissions (AE), but also by measuring the evolution of P and S-wave velocities during heating/cooling. Several attributes of the AE signal (energy, amplitude, duration, etc.) will systematically be studied to delve deeper into the physics of thermal cracking with increasing temperature. The experiments will be performed over a large range of temperatures (25 to 900 °C) and at different heating/cooling rates (from 1°C/min to thermal shocking at ~ 100 °C/s). Porosity and permeability will systematically be measured before and after thermal stressing. These new data should enable us to discuss several fundamental questions about the importance of grain/crystal size, the prevalence of the thermal cracking during cooling and heating, the existence of a Kaiser “temperature memory” effect, and the influence on fluid flow at various scales in different crustal environments.
The second objective of this project will be to study another fundamental related question: to what extent do thermal microcracks impact of the mechanical strength of rock? Pilot studies suggest that the effect could be quite different at low and high confining pressures, but to date no systematic study has ever attempted to resolve this issue. A series of triaxial experiments will be performed on intact and thermally-stressed samples. Elastic moduli and failure conditions will be quantified for various rock types over a large range of confining pressures. Further, we will identify the in-situ conditions at which the compressive strength is influenced by thermal microcracking (using our new state-of-the-art high temperature triaxial press). A micromechanical model involving the effect of thermal microcracks will be developed at the end of the project on the basis of our experimental results.