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Evolution in physical properties of crustal rocks submitted to large temperatures

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Rock at depths may be submitted to high temperatures, and high temperature gradients. Such occurrences may be natural, from the slow sedimentary burial to the fast heating in zones near active faults, or anthropic, due to cold fluid injections into a hot reservoir rock for geo-engineering purposes. The current knowledge is that high temperature gradients induce microfracturing, which is particularly intense beyond 575°C, when the quartz alpha-beta transition in quartz-bearing rock is reached. Until now, most of the existing work was carried on granites, a crystalline rock of very low porosity and of about 20-30% quartz content. It remains of interest to investigate whether this holds true for very different mineralogical compositions or rock initial porosity, and how it affects both elastic and electrical properties of rocks, the two properties that can be obtained at the field scale.
For this purpose, thermal treatments of different temperatures, in the range of 100°C to 1000°C, are applied to samples of granite, diorite and sandstones. The samples are characterised in terms of evolution in connected porosity, P- and S-wave velocities, and electrical formation factor. Preliminary results show that : (i) the increase in porosity from thermal treatment is very dependent on the initial porosity and grain size; (ii) the decrease in formation factor (i.e. increase in pore connectivity) solely depends on the initial porosity of the rock sample; and (iii) independently of any parameters, relative drops in P-wave velocities are extremely consistent for all rock samples, start at temperatures of 400°C and, interestingly, find its asymptote at the temperatures of the alpha-beta transition.