Determination of specific heat capacity of rocks by DSC before and after high-temperature thermal cycling

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Rocks are considered an attractive storage material for thermal-energy storage (TES) at high temperatures. However, the literature lacks detailed experimental data on the effects of thermal cycling on the thermophysical and mechanical properties of rocks. The first objective of our study was to fill this gap in the literature through a quantitative assessment of the effects of thermal cycling on the specific heat capacity of selected rocks using a temperature range and a heating rate that are representative of a TES at steady cycling.

Six types of rocks of Alpine origin were investigated, five of which were previously used in experiments with a lab-scale and a pilot-scale TES. The rocks were classified as mafic rocks, felsic rocks, calcareous sandstones, limestones, quartz-rich conglomerates, and serpentinite. The rocks were thermally cycled between about 100 and 600 °C with a heating rate of 2.6 °C/min. Measurements of the specific heat capacity were performed by differential scanning calorimetry (DSC) before thermal cycling as well as after 20 cycles.

Thermal cycling was found to lead to decrease in the specific heat capacity of the rocks. This effect is explained by chemical reactions such as mineral dehydration starting at about 400 °C, decarbonation of calcite, and deserpentinization above about 600°C, leading to a loss of volatiles (H_2O and CO_2) from rock samples. The different extents in the decrease of the specific heat capacity of each rock are attributed to its initial mineralogical content (i.e., abundance of hydrate minerals and/or calcite). Establishing a quantitative correlation between the amount of volatiles lost and the decrease in the specific heat capacity was not feasible due to the heterogeneity of the rock population. The development of such correlation will be the goal of a future study on homogeneous standard rocks.

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