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Geomechanical characterization of the Upper Carboniferous under thermal stress for the evaluation of a High Temperature – Mine Thermal Energy Storage (HT-MTES)

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The goal of this R&D project is to create a technically and economically feasible conceptual model for a High Temperature – Mine Thermal Energy Storage (HT-MTES) for the energetic reuse of a mine on the example of the Prosper-Haniel coal mine in Bottrop, Germany. This project is funded by the "Initiative Energy Storage" program of the German Federal Ministries BMWi, BMU and BMBF.

At the end of 2018, the last operative coal mine in North Rhine-Westphalia, Germany (Prosper-Haniel), is going to be closed down, plugged and abandoned. Large amounts of subsurface infrastructures, resembled mainly by open parts of former galleries and mining faces are going to be flooded, after the mine is closed down and therefore have the potential to become an enormous geothermal reservoir for a seasonal heat storage. During the summer non-used (waste) heat from solar thermal power plants, garbage incineration, combined heat and power plants (CHP) or industrial production processes can be stored within dedicated drifts of the mine. During the winter season, this surplus heat can be extracted and directly utilized in commercial and/or residential areas.

For the evaluation of such a HT-MTES within a former coal mine, the corresponding geomechanical parameters of the Upper Carboniferous under thermal stress needs to be evaluated. Therefore the main rock types of the Upper Carboniferous (claystone, siltstone and sandstone) are subject to a geomechanical characterization before and after thermal cyclic loadings of temperatures up to 200 °C. The samples have been collected directly from the coal mine Prosper-Haniel within a depth range of 1000 – 1200 m. Unconfined compressive and tensile strengths, as well as triaxial tests were performed at room temperature. Furthermore, a range of petrophysical properties like density, thin-section analysis and P-wave velocities were determined. First results show an indication that the overall strength properties of the samples are not effected by thermal cyclic loadings with temperatures of up to 200 °C. However, a reduction in the Young's modulus was observed in all samples, after thermal cyclic loads were induced. This effect is mainly correlated to a relaxation of the grain bonds and a pore space expansion. Currently, the experimental focus was set on the evaluation of the collected siltstone samples. Therefore further experiments are needed to undermine these results also for the claystone and sandstone samples.