The role of the subsurface in the energy transition – (some of) the (scientific) challenges

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The transition towards carbon-free, renewable based energy systems is a central element to limit global warming and is one of the key societal challenges we are currently facing. The subsurface offers many different pieces for the energy transition jigsaw, from renewable energy from geothermal sources to large volumes of pore-space to permanently sequester carbon dioxide. The subsurface also provides several options for storing renewable energy over seasonal timescales, by storing renewable energy surplus converted into hydrogen and compressed air. As the subsurface can be utilized for many different energy related purposes, it becomes clear that it has to be a crucial part of the energy-transition. However, most subsurface utilization technologies are not yet used on the scale that is needed for a successful energy transition. One reason for this lies in the incomplete understanding of (geological) processes that occur in the subsurface during, and after, the operation of these technologies. Predicting the performance and the potential of subsurface utilisation in the energy transition can also be hampered by limited data availability and the uncertainties associated with sparse datasets. Here, some of the key geoscience challenges that need to be solved for a timely energy transition are presented and some potential solutions are reviewed. The subsurface can, and must, play an important role in tomorrow’s green energy systems!