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Assessing the geological potential of the Lower Muschelkalk as High Temperature - Aquifer Thermal Energy Storage (HT-ATES) horizon in Berlin (Germany)

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High Temperature - Aquifer Thermal Energy Storage (HT-ATES) offers a promising opportunity for climate-neutral heat supply in urban areas due to their high storage capacity and the possibility of direct integration into the regional district heating system. The assessment of the storage potential of HT-ATES requires reliable numerical models of the corresponding storage formation. To analyse the potential of the Lower Muschelkalk (Middle Triassic) as HT-ATES horizon, an unstructured 3D finite element model of the natural gas storage facility in Berlin/Spandau was developed. At this site, two porous layers (average porosity of 22 %) of oolithic grainstones characterize the target formation with a total thickness of about 30 m and a natural reservoir temperature of 32 °C in a depth of 535 m below ground surface. Beside lab analysis of core samples and fluid samples from the site, slug-withdrawal tests were performed in summer 2021 to identify hydraulic key parameters for the numerical simulations. The results indicate a productivity between 0.5 and 1.2 l/s/bar with reservoir permeability between 250 and 700 mD allowing maximum flow rates between 55 and 135 m³/h. In this study, we present a complete workflow from geological characterisation, lab analysis and field testing to detailed numerical HT-ATES simulations. Furthermore, we compare the storage potential based on different data sources such as solar heating systems and district heating networks. First results from the numerical simulations with storage volumes between 15,000 m³ (solar heating system) and 400,000 m³ (district heating system) show promising mean efficiency values between 60 % and 90 % within 25 years of operation. The hydraulic tests and the underlying numerical simulations indicate that the Lower Muschelkalk is suitable for HT-ATES.