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Geothermal Potential of the Upper Muschelkalk in Northeastern Germany

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In man-made geothermal reservoirs subsurface heat exchangers are created in which water is repeatedly injected, heated and pumped up in order to produce heat and electricity. Commonly doublet-systems are used that consist of injection and production wells. The temperature of the produced water should be sufficiently high (for electricity production more than 100°C) for a period of tens of years. In continental areas with normal geothermal gradients this temperature is reached at depths of several kilometres. For geothermal reservoirs to be of economic use, a necessary condition is that there is a high flow rate in the order of 10-50 l/s of hot water through the rock. In most geothermal reservoirs, particularly in man-made reservoirs, fluid transport is through rock fractures, that is, the host-rock permeability is fracture-controlled ("fractured reservoirs"). The permeability of a geothermal reservoir can be increased through stimulation, either by shearing and opening of existing rock fractures or by creating new hydraulic fractures in the reservoir rock, resulting in Enhanced Geothermal Systems (EGS). The Upper Muschelkalk (Middle Triassic) is a horizon explored to be used as a geothermal reservoir in the Upper Rhine Graben area. There occur well-connected fracture systems that allow the formation of EGS or even hydrogeothermal usage without further stimulation, particularly in fault zones. The geothermal potential of the Upper Muschelkalk in other areas, however, has not been investigated in detail previously.

Here we present a map of the geothermal potential of the Upper Muschelkalk in Northeastern Germany. The data on the depths and thicknesses are composed from 54 deep drill holes (pubslished data). The depth of the top Upper Muschelkalk ranges from 41 to 3200 metres; its thickness ranges from 75 to 200 metres. The data are interpolated using ordinary kriging with cross-validation. We then combine the depth-map with a geothermal gradient of 36 K/km to depict a temperature distribution map of the top Upper Muschelkalk. Finally, the required temperatures for various forms of geothermal usage (e.g., electricity production, district heating) are combined with the temperature distribution map to obtain the map of the geothermal potential. Here, it is taken into account that relatively high thicknesses and interconnected fracture systems are needed in order to provide the necessary flow rates of geothermal water. The map shows relatively large areas, where electricity production should generally be possible from the Upper Muschelkalk geothermal reservoir in Northeastern Germany.