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# INFLUINS: Investigating fluid flow between surface and deep levels of sedimentary basins: The Thuringian Basin as a geolaboratory

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Underground fluid flow, in particular through porous sediments and sedimentary rocks, is of prime importance to many human needs and activities, from the supply of clean drinking water to the extraction of hydrocarbons or geothermal energy. Rapidly circulating fluids near the surface are linked to slower circulation systems reaching depths of many kilometres. INFLUINS is a research initiative to study these coupled fluid systems on a regional scale for a specific basin, the "Thüringer Becken" (Thuringian Basin, TB). The TB is a gentle depression some 130 km long in NW-SE direction and 70 km across located in east-central Germany. Its surface elevation is $\sim$200-300 m and it is surrounded on three sides by hilly terrain rising to $\sim$700 m. The most prominent ranges are the Harz Mountains in the northeast and Thüringer Wald in the southwest. Geologically, the TB is a wide and very shallow syncline in mostly Triassic sandstone, limestone and shale with some intercalated evaporites. The main aquifers are in sandstone and thin, partially karstic limestone layers. At its base, this succession is separated from the Variscan basement by a thick layer of Latest Permian Zechstein salt. At the top, the Mesozoic strata are locally and disconformably overlain by highly permeable but thin Tertiary and Quaternary strata. The TB originated as a part of the Northeast German basin. Although Mesozoic strata younger than Early Jurassic are largely absent, thermochronologic and maturity data suggest its rocks had a similar subsidence and diagenetic history governed by cooling and extensional tectonics up to the early Late Cretaceous. Northwest trending fault zones within the TB probably nucleated during this period. The latest Cretaceous inversion event created the synclinal structure of the TB, induced the reactivation of the extensional fault zones and raised the Harz and Thüringer Wald basement anticlines. Thrust faulting and folding was accompanied by regional uplift inducing erosion on the order of 3000 m before continuous deposition resumed over the northern part of the TB in Eocene time. Pleistocene ice sheets covered more than half of the TB during their maximum extent and must have profoundly altered its hydrodynamics. Today, the main driver of basin-wide groundwater flow must be the topographic head from the elevated borders to the basin axis. Near the surface, most of the TB is drained towards the northeast by the Unstrut and Saale rivers and their tributaries. The hydrologic outlet coincides with the structurally lowest part of the basin border and high (sub-)recent subsidence rates, attributed to subsurface dissolution of evaporites. This suggests focussed outflow of deep groundwater in this area. Thermohaline circulation throughout the TB is likely hampered by its flat shape and multiple aquitards. Nevertheless, saline fluids rising along the fault zones attest to deep fluid cycling in the TB and the role of faults in its hydrodynamic segmentation. Convection might occur in smaller, more equant-shaped compartments, aided by permeable fracture zones. INFLUINS comprises 12 subprojects targeted to study the TB′s fluid dynamic system. Individual subprojects deal with the regional structure from geophysical and geological data, the hydraulic characteristics of aquifers and faults, meteorology, the composition of both fossil and recent fluids and precipitated mineral phases, tracing groundwater chemistries and microbes to areas of origin as well as InSAR analysis of fluid-induced vertical motions. A central experimental site includes a drill hole planned to traverse the sedimentary succession down to the Zechstein. Drilling will be proceeded by acquisition of new seismic and magnetic data and accompanied/followed by geophysical and hydrogeological monitoring. Numerical modelling as well as geotechnical development and application are further core areas.