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High-resolution reconstruction of three-dimensional sedimentary aquifer analog: the Herten case study

Peter Bayer (1), Alessandro Comunian (2), Julien Straubhaar (2), Peter Huggenberger (3), and Philippe Renard (2)

(1) Engineering Geology, Geological Institute, ETH Zurich, Sonneggstrasse 5, CH-8092 Zurich, Switzerland (bayer@erdw.ethz.ch), (2) Centre of Hydrogeology and Geothermics (CHYN), University of Neuchâtel, Rue Emile-Argand 11 CP 158, CH-2009 Neuchâtel; Switzerland , (3) Geological Institute, University of Basel, Bernoullistrasse 32, CH-4056 Basel, Switzerland

In recent years, analog studies have contributed to an improved understanding of those geological structures that control flow and transport in natural aquifers. Special attention has been drawn to unconsolidated sedimentary deposits, which host many of the important shallow aquifers in Central Europe. Among these are relatively young fluvio-glacial and fluvial sediments in the Rhine basin. Gravel pits found in excavation show excellent sections of the sedimentary sequence and thus offer direct insight into the structural and textural composition of the subsoil. A major problem is that usually analogs are obtained from single outcrop walls, which only deliver a cross-sectional profile but hardly capture the true three-dimensional conditions. This study describes an approach to also examine the third dimension: by mapping during the ongoing excavation it is possible to obtain a three-dimensional representation of a local field of observation within a short period of time. A detailed description of this "Herten case" is presented and the findings from sedimentological, hydrogeological and geophysical analyses are compared. A medium-scale (16m x 7m x 10m) gravel body is studied that delivered a high-resolution data set of lithofacies, hydrofacies and ground penetrating radar (GPR) profiles. The three-dimensional (3D) structure is reconstructed in a hierarchical framework by multiple point geostatistics. The developed aquifer analog model reproduces realistic geological structures, and it respects the vertical distribution of the proportions of the conditioning data. It can serve as ideal research benchmark for a variety of applications in hydrology and hydrogeology.