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Detection of the subsurface structure in the Metropolitan region of Hamburg

The HADU-Project (Hamburg - A Dynamic Underground)

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The focus of the HADU-project is the identification and evaluation of shallow and deep subsurface structures in a dense built-up area. The applied techniques comprise ground-penetrating radar (GPR) and shallow drillings for near surface structures (Geological Research Group, Department of Geosciences, University of Hamburg). To detect the deeper structures, the Geophysical Research Group, Hamburg and Potsdam Universities is using ambient seismic vibrations technologies with online-processing and gravity methods. The computer science group (Information Technologies, Hamburg University) is responsible for comprehensive data management.

Our goal is (a) the evaluation of a possible geological hazard potential in the metropolitan region built on soft sediments partly underlain by salt diapirs and (b) a 2- and 3-D modelling of geological underground structures on various scales beneath the city of Hamburg.

Hamburg is geologically situated in a late Tertiary basin with Quaternary and recent sediments. Near surface and shallow subsurface deposits are represented by more or less consolidated glacial, interglacial and postglacial gravel, sand and clay. Peat infill-

ings occur in bowl-shaped structures; their formation is often unknown. The special geological situation of Hamburg is manifested in the occurrence of four salt-diapirs beneath the city. One of them, the Othmarschen-Langenfelde diapir (OLD) reaches up close to the surface. The diapir-top is restricted to an area of 3 x 4 km. Here percolating rainwater and/or groundwater can locally dissolve the evaporitic rocks. This induces corroding fissures and instable collapse-endangered cavities. During the last two centuries about 20 sinkholes have been formed. The last Hamburg collapse earthquake happened on the 8^{th} of April 2000.

The purpose of the GPR investigation is to localize and characterize buried bowl shaped structures and depressions down to a depth of 15 m and to unravel their evolution. Some are due to subrosion processes in the roof of the salt-diapir and reflect creeping downwarping or sudden collapse events. Others represent relicts of the ice-ages and are kettle-holes. Peat samples provide pollen material for age determinations of the subsidence structures. Some of them originated already 8000 years ago and can be active into present times.

The mapping and analysis of the deeper structure of the OLD is performed by low-cost, passive geophysical methods as ambient seismic vibrations combined with gravity measurements Ambient vibrations measurements comprise mainly shear wave velocity profiles and can be carried out down to depths of several hundred meters. The gravity data, combined with structural information from seismic methods, is sensitive to the deep salt structures and complements the other measurements with the aim to resolve the spatial extend, the highs and lows of the OLD.

The computer science group concentrates on data handling, visualization of geo-data, and the integration of Fuzzy-methods to handle incomplete and uncertain geophysical data.