Geophysical detection of caves to prevent natural hazards – Two case studies from Lower Austria

Funk, Barbara (TU Wien, Wien, AUT);
Flores-Orozco, Adrian (TU Wien, Wien, AUT);
Plan, Lukas (Naturhistorische Museum Wien, Wien, AUT)

The study area is located near Lunz in the Northern Calcareous pre-Alps at the contact of well bedded limestone (Opponitz Formation) and massive dolomite (Hauptdolomit), both from the Upper Triassic. At the study area electrical resistivity tomography (ERT) and ground penetrating radar (GPR) have been performed to gain information about changes in the electrical properties of the subsurface that could help in the delineation of the cave system. Two case studies are presented: (1) the Forststraßeneinbruch and the (2) Stiegengraben Wasserhöhle. The Forststraßeneinbruch (length 147 m, depth 24 m) was first reported due to a hole opened in a forest road in December 2016. From the survey, it was clear that also other parts of the cave are close to the surface (adjacent to infrastructure) as well. The aim of the geophysical investigation was to delineate the location of further surface near caves that potentially collapse. As there is access to Forststraßeneinbruch and thus a precise cave survey exists, it was possible to compare the results of the geophysical measurements with the real cave extent and thus to check the achievable accuracy.

The Stiegengraben Wasserhöhle is a 1 km-long cave buried by coarse gravel during the construction of a forest road in the 1970's and by a lot of fine grained material recently. The cave acts as a spring during flood conditions but the water could escape through the coarse gravel. Now it is feared that due to the recently plugging of the spring with fine grained material the water pressure could rise inside the cave and mobilize the unconsolidated material, which could result in a debris flow, endangering the houses in the valley below. Ground penetrating radar (GPR) and electrical resistivity tomography (ERT) were used to detect the exact position of the former entrance in order to allow the planned reopening. Here the geophysical investigation aims at identifying the geometry of the cave, as well as the accumulation of fine materials, or water saturated voids.

For the ERT measurements a system with 72 electrodes with 1 m spacing was used, which yielded a penetration depth of 15-20 m. Above Forststraßeneinbruch seven partly intersecting profiles were measured. Due to the dense forest, only five GPR measurements were possible along the same profiles. Therefore, both a 200 MHz and an 80 MHz antenna were used. With the 200 MHz antenna a penetration depth of about 10 m and with the 80 MHz antenna of about 30 m could be reached. Above Stiegengraben Wasserhöhle two profiles were measured along the forest road. Both with ERT and a 400 MHz GPR antenna.

Our results show that ERT is a well suited method which permits to gain detailed information on the geometry and interconnection of the cave system. GPR permits a faster data collection, yet the interpretation of such data is highly improved using the ERT results. Also the comparison of both geophysical methods with the cave survey showed a good agreement.