



Cross-borehole imaging of paleokarstic phenomena at the origin of a collapse near a building

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Following a collapse occurred close to a building, cross borehole electrical resistivity tomographies were implemented to detect and image paleokarstic phenomena (also known as 'ghost rock') at the origin of collapses observed in the Tournaisis (western Belgium). Indeed, low electrical resistivities of weathered limestones and eventual in-filling in palaeokarstic features contrast with the higher resistivities of sound limestones.

The aims were to determine the nature and the structure of the subsoil, especially to identify and to locate the potential presence of paleokarstic features and alteration phenomena within the limestone bedrock under the building

In order to carry out measurements, 15 boreholes were drilled around and inside the building so as to acquire enough data and provide a good resolution. The boreholes were equipped to perform electrical resistivity tomographies under the building down to 25m below the ground surface. The equipment was planned to be reused for control and additional measurements.

Drilling follow-up shows that the limestone rockhead may be strongly weathered over thicknesses reaching 10 meters. The top of the limestones is often highly weathered. Below this weathered layer, hard and rocky levels alternate with soft and low consistency levels. Voids have also been intersected by several holes at different depths. The larger voids were usually present in weathered limestone just below harder levels. During grouting operations in the boreholes, a connection between voids was highlighted. These voids pose a threat to the stability of the building because they can be the source of new instabilities under or in the immediate vicinity of the building.

In total, 31 tomographies were performed between pairs of boreholes. These were inverted separately and relocated in three dimensions for interpretation. This model highlights the very irregular nature of the contact between limestones bedrock and residual weathered limestones. It leads to consider that the relief of the bedrock is very rough under the building but also surmounted by rock with very variable consistency. Tomographies also indicate the possible presence of boulders floating in an altered mass.

Additionally, geological penetration radar measurements were carried out in some boreholes to try to better delineate the voids crossed while drilling. Measurements were made in reflection mode with 150 MHz and 300 MHz central frequency antennas. After processing, the radar profiles generally show reflections corresponding to the contacts between layers and confirm the presence of voids. Measurements in cross-hole tomography mode were also attempted with the 150 MHz antenna but without success given the high attenuation in the medium.