Geophysical Research Abstracts, Vol. 9, 08911, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-08911

GPR as a tool to detect and characterize subsidence and collapse associated with shallow karst. Examples from the Central Ebro Basin (Spain)

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Geophysical surveys have been widely applied to detect and characterize karst hazards. Ground penetrating radar (GPR) has demonstrated its applicability in this subject. Geotransfer Research Group from the Zaragoza University, in the last years has applied for several years geophysical, geological and geomorphological techniques to detect, localize and characterize potential karst hazards.

GPR offers high resolution electromagnetic cross-sections and is a near continuous geophysical technique. Traditional applications of these surveys have been mainly the detection and localization of cavities and paleocollapses in the subsoil.

The Ebro-Basin, is the foreland basin to the Pyrenees and the Iberian Chain. It was an endhorreic basin during the Oligocene and the Miocene. The sedimentary system had alluvial fans in the basin margin and evaporitic areas in its central part. Zaragoza is located in the central part of the Ebro basin, with a horizontal sequence consisting of Miocene evaporitic and lacustrine sediments. Quaternary alluvial sediments cover the Miocene sediments in the basin centre related mainly with the Ebro river system. The evaporitic karst has been active during the Quaternary and is still active. The karst evolution is related with active dissolution processes affecting the Miocene materials and subsequent accommodation of the quaternary series. The quaternary series shows collapses, accommodations, bending and superficial subsidence zones depending on the cohesion of the different materials.

In this work we present a model to detect, localize and characterize karst hazards by means of the GPR. There are three different aspects associated with karst hazard, that

can be distinguished by means of the GPR. The continuous features of active subsidence processes can be grouped in three vertices of the gpr-doline triangle. The vertices of this triangle are: cavities, paleocollapses and continuous subsidence. The most common occurrences are intermediate cases of these three different end-members.

The detection and characterization of cavities and paleocollapses is straightforward by the interpretation of the profiles. The presence of accommodation processes, due to active subsidence processes, can be detected by the study of individual reflectors in the profiles and its lateral correlation.

Curved reflectors, on-lap geometries and depth penetration variations are positive indicators of subsidence zones, although these features could be related also with sedimentary structures. Two-fold surveys and an adequate density of profiles could help determining the 3D structure and its plan view. The determination of closed envelopes of subsidence features can help to localize and characterize karst hazards even in the case that the gpr survey do not reach the depth of the process origin.

The GPR surveys is an efficient tool to localize, detect and characterize karst hazards in the surroundings of Zaragoza because sedimentary structures are simple and the quaternary cover usually shows show indicators of karst processes. The methodology proposed here can be an efficient guide for building and engineering studies and for another geophysical surveys.