Subsidence Hazard in Limestone Cavities: The Case of "Grutas da Moeda"

Duarte, I. M. R.[1]; Pinho, A. B.[2]; Lopes, L.[3] Sábio, R.[4]; Jorge, M.[5]

[1]University of Évora, School of Science and Technology, Department of Geosciences, GeoBioTec, Évora, Portugal, email: iduarte@uevora.pt
[2]University of Évora, School of Science and Technology, Department of Geosciences, GeoBioTec, Évora, Portugal, email: apinho@uevora.pt
[3]University of Évora, School of Science and Technology, Department of Geosciences, ICT, Évora, Portugal, email: lopes@uevora.pt
[4]Grutas da Moeda, São Mamede, email: ricardo.sabio@grutasmoeda.com
[5]Grutas da Moeda, São Mamede, email: micael.jorge@grutasmoeda.com

ABSTRACT

"*Grutas da Moeda*" are natural touristic caves, located in the plateau of São Mamede, 5 minutes away from the Sanctuary of Fátima. They have been opened to the public since 1974, and receives about 75,000 visitors per year, from 76 nationalities. They are inserted in the "*Maciço Calcário Estremenho*", composed by limestone deposits of the Middle Jurassic (Bathonian), corresponding to the Serra de Aire formation and Upper Jurassic limestone deposits corresponding to the Cabaços and Montejunto formations.

The geological risk assessment is fundamental to guarantee the safety of its visitors and workers, therefore it is intended to develop methodologies of geotechnical monitoring in order to collect data to understand the risks that may be associated with this natural cavity and to identify critical areas of collapse. In the caves there are four main alignments (faults / joints), N35ºW, N150ºE, N75ºE and N100ºE, which assume a parallelism with the development of the caves. The trend of the layers in the cave are approximately N30ºE pending 17ºSE. In the year 2015, a geophysical study was carried out in the caves, using the 3D electrical resistivity method and, for one of the areas in particular, the georadar method. The georadar method allowed to map the anomalies corresponding to empty spaces that have been identified with the 3D electrical resistivity technique. This paper presents the results obtained, as well as proposals for geotechnical measures to mitigate the risk of collapse subsidence.

KEYWORDS:

Subsidence Risk

Limestone Cavities

Geological Hazards

Geophysical Methods

Geotechnical Monitoring