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Quantitative evaluation of the underground Geoheritage in karst areas: The Picos de Europa National Park, North Spain

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Karst areas show a lot of kilometers of cave conduits with a hidden Geoheritage poorly investigated in previous works that concerning with their cultural, scientific and education values. The evaluation of cave Geoheritage is complex due to methodological constrains. One of the most important karst areas in the World is the Picos de Europa National Park (North Spain) that was declared as a Global Geosite in 2007 and includes 14 % of the World's Deepest Caves. The GEOCAVE research project is being developed in several caves from the Picos de Europa National Park since 2012 in order to characterize geomorphology and geochronology of the cavities, proposing and validating new methodologies adapted to these environments. The aim of this work is to evaluate the Geoheritage of the Picos de Europa caves based on the studies made in nine selected caves. The methodology includes: 1) elaboration of geomorphological maps of the nine selected caves, projecting geomorphological, geological, hydrogeological, paleontological and cultural forms on the caves surveys; and 2) definition and calculation of three indexes useful to evaluate the Geoheritage of the caves. The indexes are: a) Cave Geoheritage Extension Index (CGhEI), defined as the percentage of the area occupied by the entire features divided by the cave area (excluding the forms that represent the conduits themselves), b) Feature Extension Index (FEI), defined as the area occupied by each group of form divided by the cave area, and c) Cave Geodiversity Index (CGdI), defined as the number of forms divided by the cave area. The nine cave geomorphological maps cover 178,639 m2 of caves and include a whole of 14.9 km of karst conduits, representing these caves the 4.1 % of the conduits of the Picos de Europa. The values of the Cave Geoheritage Extension Index range from 22 to 82 %, while the values of the Feature Extension Indexes for each group of features reach the following values: Geomorphological FEI take values of 20-80 % (speleothems FEI is 15-60 %, fluviokarst FEI is 5-25 %, gravity FEI is 10-40 %); Geological FEI is 4-5 %; Hydrogeological FEI is 0-3 %; Paleontological FEI is 0-0.1% and cultural FEI is 0-4 %. the On the other hand, 84 features are recognized into the caves and the Cave Geodiversity Index ranges from 0.3 to 1.1 features/cm2. These results evidence that 22 to 82 % of the cave conduits are occupy with Geoheritage features, being most of them geomorphological forms (speleothems, fluviokarst and gravity forms). The Geodiversity of the karst caves is high, recognizing a whole of 84 features into the caves and showing a high density of forms. Consequently, underground Geoheritage from karst areas can be estimated combining geomorphological maps few selected caves and three indexes based on number and extensions of the features. These indexes allow us to assign a preliminary weight of the geomorphological, geological, hydrogeological, paleontological and cultural features in a karst area.