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Preliminary characterization of an alpine karst aquifer in a complex geological setting using the KARSYS approach. Picos de Europa, North Spain

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Research applied to karst aquifers linked to a homogeneous limestone in high mountain areas affected by several tectonic events is a hard task, due to methodological constraints and the uncertainties of the geological data. The KARSYS approach (Jeannin et al. 2012) is based on the combination of existing geological data and basic principles of karst hydraulic, allowing for characterizing the geometry of an aquifer considering a smaller amount of data than other methods. The Picos de Europa (North Spain) is an alpine karst massif with a surface area of 700 km2, peaks up to 2,648 m and fluvial gorges up to 2,000 m deep, including about 270 km of cave passage. The bedrock is mainly composed of Ordovician quartzite covered by massive Carboniferous limestone and is affected by two systems of thrusts and other faults. The most of the geological structures are from Variscan orogeny (Carboniferous in age), some of them could be originated or modified during the Permian-Mesozoic extensional episode, and the others were originated or reactivated during the Alpine Orogeny. Therefore, the Picos de Europa can be considered as a complex geological environment in which usual hydrogeological methods are difficult to use. The aim of this study is to characterize the geometry of the Picos de Europa aquifers applying the KARSYS approach. The approach includes: 1) the identification of aquifer and aquiclude formations; 2) the inventory of the main springs; 3) the establishment of a 3D geological model, focused on the aquifer boundaries; 4) the implementation of the hydraulic features within the 3D model and the delineation of the karst system. The main aquifer of the Picos de Europa is developed within the Carboniferous limestone and displays a complex geometry generally limited and divided into several unconfined groundwater bodies by Ordovician to Carboniferous rocks related to the thrusts. The lowest limit of the aquifer is marked by the N-dipping detachment level of the thrusts and the top of the Ordovician rocks, pushing the underground flow paths towards the northern part of the massif. Some boundaries of the saturated part of the groundwater bodies are unknown, although they could be associated to some rocks not considered in the geological model. The main karst springs supply 10 to 5,000 l/s, being located at altitudes ranging from 167 to 1,246 m (western area), and 178 to 440 m (central area) and at 600 m (eastern area). Their elevation is progressively decreasing toward the North, conditioning the regional circulation of karst groundwater. These results suggest that the geometry of the saturated part presents several compartments, resulting from the position of the out-of-sequence thrusts, with a relative elevation descending to the North. The results evidenced by the KARSYS approach provide first outlook of the geometry of the karst aquifers of the Picos de Europa, even if deep geological data are not precise or are scarce. The method has also revealed the main targets for future geological and hydrogeological research in this complex karstic environment.

Jeannin et al. 2012. Environmental Earth Sciences DOI10.1007/s12665-012-1983-6.