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Speleogenesis is the study of how cave systems develop. It attempts to demonstrate how a carbonate rock unit passes from an initial non-karstic situation to some end point wherein the dissolution process has created a karst cave system. Models for unconfined aquifers require structural pre-cursors including joints and/or bedding planes along which the cave propagates. In understanding the karst of the escarpment, including the development of sinkhole to spring systems ("macrokarst") and pathways for percolation water ("microkarst"), models must be based on a conceptual framework consisting of variously pre-opened fissures. The model must explain cave development on the Niagara Escarpment in terms of the opportunistic capture of surface water through a complex system of discontinuous inherited structures.

950 - Hydrogeological approach for groundwater flow and protection in karst using a 3D model – Case study of the Beljanica Massif

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The protection of karst groundwater, which represents an important resource for the future, is gaining in importance as one of the key parameters of regional planning and development of karst regions. Karst is known as an extremely sensitive environment to any change, and reactions that are happening according to these changes are usually rapid and drastic. This is why karstic aquifers and groundwater must be under strict protection. However, the criteria for the definition of sanitary protection zones in karstic terrains are significantly different from the current criteria applied in nonkarstic terrains, especially when dealing with large massifs draining only on few concentric points. Determination of the sanitary protection zones and development of groundwater vulnerability maps are the main prerequisites for successful strategy of karst massif and aquifer protection.

One of the methods for good zoning of protection areas is 3D modelling of the karst interior. This paper includes an analysis of the discharge regime of major springs based on historical and newly collected data, the correlation of spring discharges with physico-chemical characteristics of the spring waters, and the main findings of the created 3D ArcGIS model of the karst interior. Only "strict" principles and measures to protect karst water are possible to preserve the aquifer for future local and regional water supply. One good example is the Beljanica karst aquifer whose reserves are released (estimated) at about 3 m^3/s minimum. This makes a good basis for the use of regional water supply purposes.

778 - Stable isotope studies on altitude effect and karst groundwater catchment delineation of the Jeita spring in Lebanon

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The Jeita spring in Lebanon is the main water resource for Beirut, the capital of Lebanon. More than 40% of the groundwater catchment is located on a plateau with elevations between 1,800 and 2,600 m above sea level. Between November and May this area is covered with snow which provides the main source of groundwater recharge in the Jeita catchment. The catchment is intensively karstified and topographic gradients are rather steep so that runoff stops shortly after snowmelt. The complex groundwater flow path, however, provides that even at the end of the dry season spring discharge at Jeita rarely decreases below 1 m^3/s. Isotope hydrological methods are known to provide powerful information for water resources management especially in karstic environments.

In this work stable water isotopes (deuterium, δ^2H, and oxygen-18, $\delta^{18}O$) from five springs (Jeita, Kashkoush, Naber al Labbane, Naber al Assal, and Afqa) were studied, monthly samples have been collected since April 2011. Additionally samples from the Jeita spring will be collected daily during the snowmelt season in 2012. Mean values of -7.2‰ and -36‰, -6.8‰ and -34‰, -8.1‰ and -44‰, -8.3‰ and -45‰, and -8.2‰ and -45‰, for $\delta^{18}O$ and δ^2H, respectively were observed at the five springs, indicating a pronounced altitude effect in the Jeita catchment. Integral samples were collected from the snow layer in the Jeita catchment at 22 sites at altitudes ranging from 1,000 to 2,300 m above sea level (asl) at the end of February 2012, when snow height reached a maximum of more than 6 m at the highest peak in the catchment. Stable isotope variability, assumed mean altitude of spring catchments, and spring interrelations that were observed for the time series will be discussed in combination with precipitation, winter snow accumulation and snowmelt signals.