# Altitudinal $\delta^{18}O$ gradients from Chinese stalagmites provide records of Holocene humidity variation

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Humidity is one of the fundamental variables controlling the energy balance of the climate, and plays a critical role in Earth's ecosystems. Its reconstruction would aid considerably in assessing the mechanisms driving past changes observed in paleoclimate records. Paleohumidity has been reconstructed qualitatively from the pollen and tree ring data, but not yet from speleothem records, due to the uncertain interpretation of speleothem geochemical proxies. Here we propose a novel proxy for paleo-humidity based on the altitudinal $\delta^{18}O$ gradient derived from two speleothems with different altitude of rainfall recharge in closely spaced caves. We then use this proxy to reconstruct a Holocene humidity record in the middle reaches of the Yangtze river. Two factors affect the altitudinal $\delta^{18}O$ gradient of precipitation, the lapse rate of temperature and relative humidity. In the case of speleothems, the cave temperature effect (negative effect) offsets the temperature induced isotopic fractionation in precipitation (positive effect), and relative humidity is likely to be the major controller of $\delta^{18}O$ gradients between speleothems with recharge from different heights. $\delta^{18}O$ in recently formed carbonate from two caves in Qingjiang valley, Hubei, China, supports this interpretation, with larger $\delta^{18}O$ gradients in periods of lower relative humidity. Based on this observation, we reconstruct Holocene relative humidity from the high resolution speleothem $\delta^{18}O$ records from Heshang and Sanbao caves. The reconstructed record indicates a slight increase in RH during the Holocene, with lowest values at 8.2 kyr BP. Independent hydrological records of Mg/Ca and $\delta^{13}C$ from the Heshang speleothem vary in a similar pattern to the altitudinal $\delta^{18}O$ gradients, which supports the reconstruction of humidity for the Holocene of this region.

# Hydrochemistry and isotope evidence of groundwater evolution and recharge in Poyang Lake, South China

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In recent decades, a systematic research of groundwater system is imperative for the increasingly prominent contradiction between supply and demand of water. In this work, environmental factors, main zwitterions, hydrogen and oxygen isotopes composition in groundwater were researched in dry season and wet season. Groundwater evolution and recharge were studied with the purposes of anzlyzing hydrochemical characteristics and evolution laws [1], as well as helping rebuild the geochemical evolution [2]. In addition, the recharge rates of different landscape units were estimated by hydrogen oxygen isotopes during investigation period.

The results show that: $Na^+$ and $Ca^{2+}$ are the main cations of groundwater in research area, and $HCO_3^-$ is the main anion, seasonal change has influence on spatiotemporal variation of area hydrochemistry, and its type is mainly present in $HCO_3^-$—$(Na^+{+}K^+)$; the composition of δD and $\delta^{18}O$ has different characteristics for seasonal change, it mainly controlled by precipitation. Groundwater anions type transforms from $HCO_3^-$—$SO_4^{2-}$ to $HCO_3^-$—$Cl^-$ when the season changes from dry season to rainy season, and cation type drifting and evoluting from $(Na^+{+}K^+)$—$Ca^{2+}$ to $(Na^+{+}K^+)$. The results of hydrogen and oxygen isotopic mixing ratios shows that there is significant difference on water recharging of groundwater system in different geomorphic units, and it reflects that the origin and evolution of groundwater response to geomorphology sensitively.

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