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Karst hydrodynamics revealed by multifaceted geochemical approaches

NATASHA T DIMOVA[1], SHANA MASHBURN[2], EVIN FETKOVICH[2], JARED N. ROSSI[2], COLIN BACIOCCO[2,3] AND DINI ADYASARI[4]

[1]University of Alabama
[2]U.S. Geological Survey OK-TX Water Science Center
[3]University of California, Berkeley
[4]Texas A&M University Galveston

The hydrodynamics of karst aquifers are highly complex, owing to the presence of preferential flow paths along numerous fractures and solution cavities within limestone formations. The time delay between rainfall events and subsequent flow into aquifers varies appreciably, making it challenging to apply coarse-scale modeling approaches. This study used combined isotopic and geochemical approaches to better understand groundwater sources and seasonal groundwater advection rates in the eastern part of the Arbuckle-Simpson aquifer in south-central Oklahoma. Radon isotope results confirmed groundwater endmembers from two distinct aquifer units (the Arbuckle Group and overlying Simpson Group) and allowed us to determine seepage rates from small surface water bodies (ponds) that responded to precipitation events. Radon isotope results show a significant variation in seepage rates between the rainy (31.2 cm/day) and dry (4.1 cm/day) seasons. Results from radiocarbon dating were used to estimate the water age at Antelope Spring, a karst spring within the study area which is at least 3,400 years old and most likely originated from the deeper Arbuckle Group, whereas the groundwater produced from wells in the Simpson Group was comparatively young (less than 560 years old). Further refinement of seepage rates would require using geochemical mixing models and stable-isotope signatures