Postprint: A Study on Structural Characteristics of Karst Water Systems in Northwestern Guangdong

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Abstract

The structure of karst water systems exerts important control on groundwater storage and contaminant transport; however, relevant studies on karst mountainous areas in northwestern Guangdong are limited. This study investigates the structural characteristics of karst water systems in a typical subterranean river system in Qingyuan, Guangdong, using multiple technical methods. The results show that karst aquifers in Qingyuan are primarily composed of Carboniferous and Devonian limestones, with hydraulic conductivity reaching up to 22 m/d, responding rapidly to rainfall events. Flood peak discharge exhibits a recession process dominated initially by rapid conduit flow and subsequently by slow fracture flow, representing a typical conduit-fracture system. Field tracer tests demonstrate that the Carboniferous karst water system possesses a single-source multi-sink structure, while the Devonian karst water system features multiple flow channels and has developed large underground pools. Karst conduits exhibit high undulation, with average conduit diameters of 1.29 m and 7.53 m for the Carboniferous and Devonian systems, respectively, and dispersion coefficients reaching 2.3–6.4 m^2/s, indicating a highly vulnerable karst groundwater environment. This study provides a theoretical basis for the development and protection of karst water resources in northwestern Guangdong.

Full Text

Structural Characteristics of Typical Underground River Systems in Northwest Guangdong Province

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Abstract

The structural characteristics of karst aquifer systems exert critical control over groundwater storage and contaminant transport, yet research on karst regions in northwest Guangdong remains limited. This study investigates a typical underground river system in Qingyuan, Guangdong, employing multiple technical methods to characterize its structural features. Results indicate that the Qingyuan karst aquifer consists predominantly of Carboniferous and Devonian limestone, with hydraulic conductivity reaching up to 22 m/d. The system exhibits rapid response to rainfall events, with flood hydrographs showing an initial peak dominated by quickflow through conduits, followed by recession governed by slow fracture flow, characteristic of a conduit-fracture dual system. Field tracer tests demonstrate that the Carboniferous karst system features a single-source, multi-sink structure, while the Devonian system exhibits multiple flow paths with extensive underground dissolution pools. Karst conduits exhibit substantial topographic relief, with mean conduit diameters of 1.29 m and 7.53 m for the Carboniferous and Devonian systems, respectively, and dispersion coefficients ranging from 2.3 to 6.4 m^2/s. These characteristics underscore the extreme vulnerability of the karst groundwater environment. This research provides a theoretical basis for the sustainable development and protection of karst water resources in northwest Guangdong.

Keywords: Northwest Guangdong; Karst groundwater; System structure; Tracer test; Conduit parameters

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Note: Figure translations are in progress. See original paper for figures.