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Identifying the groundwater flow systems in a condensed river network interfluve between the Han River and Yangtze River using hydrogeochemical indicators

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Investigation of groundwater flow patterns is vital for informing the sustainable management and protection of water resources. Hydrogeochemistry and environmental isotopes can be used to gain insight into the recharge process, water–rock interactions, and groundwater residence time, all of which can be used to accurately identify groundwater flow systems (GFSs) in an interfluve between the Han River and Yangtze River in the eastern Jianghan Plain—an alluvial-lacustrine plain in the middle reaches of the Yangtze River. Because of carbonate mineral weathering, groundwater is predominantly of the HCO_3-Ca or HCO_3-Ca-Mg type. The consistency of the evident reduction of typical ions and isotopic distributions with depth indicates that GFSs can be divided into loca and regional GFSs on the basis of a limit of approximately 20 m, that is attributable to complex anthropogenic activities, water-rock interactions and groundwater flow patterns. The distribution of δ18O indicated three evident zonations in regional GFSs that are likely dominated by the altitude effect of recharge areas. Furthermore, multiple independent local GFSs exhibited a pattern in which groundwater discharged into surface waters during the nonflood season. The regional GFS pattern is controlled by slow lateral flow from west or northwest to east, eventually discharging into the Yangtze River and Han River. Groundwater age was estimated using radiogenic (3H, 14C) isotope data and varied from the present to 5000 years, elucidating that the hydrodynamic circulation of local GFSs is active, whereas that of regional GFSs is slow to relatively stagnant. The hydrodynamic characteristics and hydrochemical distributions corroborated the occurrence of upward recharge from regional GFSs in the discharge area of the Jianghan Plain.