Hydrogeochemical indicators of a nested groundwater flow system in arid and semi-arid regions: evidence from the Aksu River Basin, Xinjiang, China

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Abstract

Studying groundwater flow systems is important for water resources management, for pollution prevention and for maintaining the ecological balance in arid and semi-arid areas. Systematic geophysics and hydrogeological investigations allow us to define the thickness of the Quaternary sedimentary layer, the lateral boundary of the groundwater system, and the depth and basement of water circulation. Hydrogeochemistry and environmental isotopes are used to gain insights into the recharge process, water-rock interactions, hydraulic characteristics and groundwater retention time and to identify groundwater flow systems at all levels in the Aksu River Basin. Owing to the dissolution of carbonate and gypsum minerals and evaporites, cation exchange between Ca^{2+} (Mg^{2+}) and Na^{+} (K^{+}), and the evaporation-concentration effect, concentrations of specific ions (SO_4^{2-}, Cl^{-}, Na^{+}) and [total dissolved solids](javascript:;) (TDS) gradually increase along the flow direction and decrease with depth (indicating that they belong to different groundwater flow systems (GFSs)). Furthermore, interpretation of stable isotope concentrations such as $\delta^{18}O$ values suggests different degrees of depletion in the horizontal and vertical directions. Combined with the unique structural framework (namely the Wensu uplift, Wushi sag, and Awat sag), the particle size variation of loose sediments and the distribution and aggregation of phreatic water with high F and As and soil salinization show the existence of the surface-ground water interaction and the distribution pattern of multiple local GFSs. The vertical zonation of ^{3}H and ^{14}C isotope concentrations and estimates of groundwater [residence](javascript:;) time (modern to 24000 years) further illustrate the hydrodynamic cycle of the local and regional GFSs. The hydrodynamic and hydrochemical characteristics confirmed the distribution of GFSs and the complex mixing relationships between GFSs in the Aksu River Basin under the tectonic conditions since the Neogene in the South Tianshan Mountains.

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