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Isotopic evidences of groundwater circulation in the Kaidu River, South Tianshan Mountains, Central Asia

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Water demand always exceeds supply in many parts of the world, especially in the arid and semi-arid regions. Groundwater is the primary input to hydrological systems like surface water bodies in polar and high mountain regions. A reasonable application of water isotopes requires a good understanding of the isotopic fractionation in processes controlling the isotopic composition of surface water and groundwater. Through the review of published papers, we find there is still scope for improving the understanding of groundwater isotopes: (1) quite few studies on groundwater circulation via kinetic fractionation of stable isotopes in the arid region of Central Asia; (2) several shortcomings on the quantitative assessment of water recycling for mountain-plain area. Tianshan Mountains, located in Xinjiang Province, is always called water tower in Central Asia and play an important role in the water cycle. In this paper, we implemented hydro-chemical index and Stable isotope mass balance method to study transformation of groundwater with surface water and to quantify recharge proportion between water bodies of typical regions. As a first step towards quantifying the contribution of groundwater, three-component mixing model of Kaidu River Basin into its constituent components has been done. Chemistry type of headstreams in this basin is mainly Ca-Mg-HCO_3, while major ions and salinity of surface water show an increasing trend with the water rising time, which could be attributable to significant features of surface water evaporation and concentration. After that chemistry type of oasis-plain area in the basin is mainly Ca-HCO_3-CO4. Groundwater recharge ratio was processed via spatial scale, it is only about 15% in upstream areas, while it accounted for 45% or more in the middle and lower reaches. Two groundwater recharge districts were divided according to the distribution characteristics of surface water. The first recharge district is from mountain area with spring overflow out to inclined plain area with alluvial, baseflow and out of groundwater become the main supply source of runoff. The second is from leading edge of alluvial plains to fine soil area. The observed similarity between the hydro-chemical index and hydrogen and oxygen isotopes of distinct water resources can be hypothesized to indicate that involve the specific properties of possibly seasonal characters and complex supply mechanism, for instance damming and agriculture. The flow directions of both groundwater and surface water deemed to be the same were also noticeable, on temporal scale there existed 3 times transforming relationship between surface and groundwater throughout the process, strongly influenced by agricultural and living water around sampling sites leading to more frequently water transformation and proportion, which performed as isotope ratios suddenly increased in midstream sampling points, thus results be interpreted further to yield more precise information about the threshold that support groundwater vulnerability exploitation. This information can be useful for further elaboration and development of detailed hydrological separation that describe the recharge relationship in arid region of Central Asia.