Migration of shallow saline groundwater across a regional aquitard inferred from Cl and stable isotope in the North China Plain

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ABSTRACT

Understanding the mechanism of salt water transport in response to the exploitation of deep freshwater has long been one of the major regional environmental hydrogeological problems and scientific challenges in the North China Plain. It is also the key to a correct understanding of the sources of deep groundwater pumpage. Porewaters were extracted from a regional aquitard (0-128 m depth) in the North China Plain and analyzed for major ions and stable isotopes. The aquitard separate regional aquifers and limits rates of water and solute fluxes between two aquifers. Porewater from the aquitard tend to be more saline and enriched $\delta^{18}O$ and $\delta^{2}H$ relative to regional groundwaters. The aquitard water between 40-120m with a range of $\delta^{2}H$ -85~ -75‰ was most likely recharged during the late Pleistocene. We extracted climate information from chloride concentrations, Cl/Br ratios, and stable isotope compositions of aquitard porewater to establish the conceptual model of water and solutes transport across a regional aquitard. We conducted 1-D flow-transport modeling for the aquitard profile by assuming constant concentration boundaries at upper and lower boundaries to reverse Kv distribution, and simulating the evaporation process on million years' time scale during late Pleistocene (dry environment). Upper part (0-30 m depth) of Cl profile is related to freshwater in wet environment during Holocene. The results show that aquitard pore water (depth >40m) have had all tracers of connate water and salts mainly formed by evaporation during the late Pleistocene (i.e. ~1 Ma BP). The Cl profile shape was altered in wet environment during Holocene (1~5 ka). Salt transport is primarily controlled by vertical diffusion on million years' time scale. Over-exploitation of deep groundwater in the past decades had caused shallow saltwater intrusion into the deep aquifers, probably passing through "windows" in 3-D domain, not through the aquitard. Interbeded sand layer has little effect on salt transport in the clayey aquitard.