



## **Evolutionary process of saline-water intrusion in Holocene and Late Pleistocene groundwater in southern Laizhou Bay**

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Saline water intrusion is one of the most serious groundwater problems in southern Laizhou Bay. In this study, formation of groundwater with different qualities and saline water intrusion were analyzed using hydrochemical and stable isotopic methods, and the Hydrochemical Facies Evolution Diagram (HFE-Diagram). The results demonstrate that the structure of the sedimentary layer in this area is the dominant controlling factor of groundwater distribution. From the south (land) to the north (sea), the hydrochemical distribution presents a regular changing pattern following the order:  $\text{HCO}_3\text{-Na}\cdot\text{Mg}$  and  $\text{HCO}_3\cdot\text{Cl-Mg}\cdot\text{Ca}$  (fresh water),  $\text{HCO}_3\cdot\text{Cl-Na}\cdot\text{Mg}$  (brackish water),  $\text{Cl-Na}\cdot\text{Mg}$  (saline water),  $\text{Cl-Na}$  (saline water) and  $\text{Cl}\cdot\text{HCO}_3\text{-Na}$  (brackish water). Hydrochemical data show that saline water and brine are not the result of evaporation or the concentration of seawater. Brackish water and saline water with low mineralization in Holocene groundwater are formed by the mixing of fresh water and highly mineralized saline water, dissolution of evaporates by meteoric water, and water/salt interaction. And the saline water formed through dissolution of evaporates in Holocene and Late Pleistocene groundwater. Isotopic results reveal that the main recharge of saline water in Holocene groundwater and Late Pleistocene groundwater is a combination of the meteoric water and lateral recharge from rivers. Saline water intrusion was found to follow a wedge-shaped intrusion pattern. Significant variations in  $\text{Cl}^-$  and  $\text{Na}^+$  indicate saline intrusion in the southern area. The degree of saline water intrusion in Holocene groundwater was found to be more serious than that in Late Pleistocene groundwater. Hydrochemical data and HFE-Diagram show that there is an intrusion process in Holocene groundwater. In this process, it is accepted the fresh water recharge, such as meteoric water and lateral recharge from rivers. In Late Pleistocene groundwater, it presents a simple intrusion process from saline water to fresh water.