Salinization processes of confined groundwater in southwestern Nobi Plain aquifer system, central Japan

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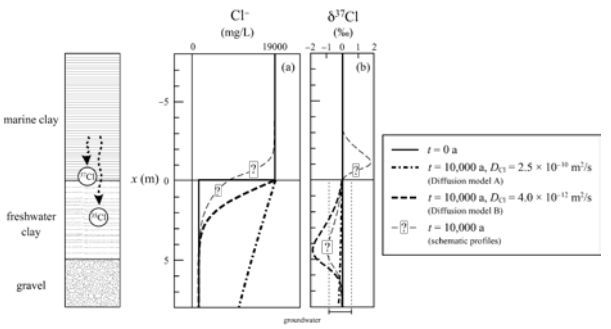
A confined aquifer system, isolated from modern seawater, is well developed in argillaceous marine and freshwater sediments of Pliocene–Holocene age in southwestern Nobi Plain, central Japan. A tongue of brackish confined groundwater (Cl^- > 1000 mg/L), which extends from the shoreline of Ise Bay inland, has somewhat lower SO_4/Cl ratios and higher $\delta^{34}S$ values (~79‰) than those of the present seawater. The groundwater chemistry could be explained by sulfate reduction in combination with the mixing of two types of seawaters, modern seawater and no SO_4 seawater, with the fresh recharge water. No SO_4 seawater may consist mainly of paleo seawater that had been trapped in an aquiclude for thousands of years. Calculations based on a Rayleigh distilation model by using Cl^- and SO_4^{2-} concentrations and $\delta^{34}S$ values showed that modern and paleo seawaters compose at most 10.7% and 9.4%, respectively, of the brackish groundwater volume in the confined aquifer. The model's discrimination of the two seawaters is also in agreement with the spatial distribution patterns of groundwater composition. That is, from the west to the east in succession, the main influence on the groundwater chemistry is fresh recharge water, modern seawater and paleo seawater. $\delta^{37}Cl$ values (from –0.90‰ to 0.21‰) of the groundwater were negatively correlated with paleo seawater Cl^- concentraitons discriminated by the model, while they are not correlated with either total Cl^- concentrations or $\delta^{34}S$ values. Furthermore, Cl^- concentrations from modern seawater are positively correlated with $\delta^{37}Cl$ values. In addition to these facts, diffusion model calculations suggest that paleo seawater Cl^- has diffused out from argillaceous marine sediments, whereas modern seawater Cl^- has not been affected by preferential diffusion of Cl isotopes because it has migrated by advection via an unconfined aquifer and non-pumping wells.



Diffusion model results of (a) Cl^- concentrations and (b) $\delta^{37}Cl$ values against distance x with schematic lithologic log.