Dear Yipeng Zhang,

We thank you for your review of the manuscript and for your comments, corrections and suggested modifications. These comments have been carefully considered and are responded to below:

**Major concerns:**
**First, the bottom boundary condition for salt is assigned to be constant value, which means that there is unlimited salt comes from underlying aquifer/aquitard. The reason to assign a constant salt boundary condition should be explained, and the potential influences of using such boundary condition on the result should be at least mentioned.**

Reviewer 1 also addressed this problem, to which we gave a similar response. In basin areas where sedimentation has taken place in a marine environment, such as the Pannonian Basin, it is a common hydrogeological situation that salinity generally increases with depth. The main reason for this is that the near-surface geological environment is in active contact with precipitation through recharge zones, while the deeper, more confined areas are much less so. Hence, the salinity of the aquitards below the basin exceeds that of the aquifers above, providing a continuous salinity supply to the basin. The phenomenon develops spontaneously in the BTK system itself, as the higher salt concentration in the low-permeability Oligocene cover persists over geological time, although it is interbedded with high-permeability aquifers from above and below. In addition, there are several hydrogeological situations where the bedrock of the basin is formed by evaporites, halite formations (e.g. Kaiser et al, 2011; 2013; Gupta et al. 2015; Magri et al., 2015; Zech et al., 2016), increasing the salinity of the basin through dissolution. Furthermore, in the synthetic parameter analysis, we varied the salt concentration of the lower boundary over a very wide range, $c_b$=2–200 g $l^{-1}$, to ensure that almost all hydrogeological situations were included.

Unfortunately, for the BTK system, there is no geological/geophysical/geochemical information available on the basement, and thus its exact salinity is not known. Therefore, a boundary condition corresponding to the initial condition (sediment deposition in a marine environment) was imposed in the model, $c_b$=35 g $l^{-1}$. However, as a consequence of the concern raised, a new simulation was also performed, in which an impermeable layer is located beneath the HS11 Lower Triassic-Paleozoic Aquitard in the BTK model, and a constant boundary condition of $c_b$=35 g $l^{-1}$ is prescribed at its lower boundary, allowing only diffuse bottom salt transport. As a result, the salinity of the confined geothermal reservoir decreased, thermohaline convection intensified, and the groundwater mean age decreased. At the same time, the nature of the complex flow regime that developed in the BTK system did not change: topography-driven groundwater flow in the unconfined karst area, thermohaline convection in the confined karst, eastern reservoir with high geothermal potential, etc. The newly performed simulation and its interpretation can be found in the new Supplementary material attached to the manuscript.

**Second, how is the application model in the BTK system verified to be representative for the pattern in the real system. Also, some discussion on the BTK system model should be added to show their implications in other regions globally.**

Agreeing with the suggestion, the Discussion was substantially expanded. In the discussion part, we have already compared the numerical solution of the BTK with (1) the temperature and salinity of observed springs, (2) the temperature and salinity of geothermal projects at shallower depths, and (3) available water age data. Furthermore, we have pointed out the strong analogy between the flow-temperature-salinity regimes of the BTK and the Tiberias Basin to emphasize that the Buda Thermal Karst system is not a unique hydrogeological formation. In the revised version of the manuscript, both sections are expanded and completed to enhance the linkage of our research to other hydrogeological systems around the world. Additional salinity observations and temperature-elevation profiles are compared to our numerical results, and two other studies (Zech et al., 2016; Kaiser et al. 2013) are presented to illustrate the connection between processes of thermohaline convection occurring in BTK and other regions.

**Specific comments:**

**Line 11 It is weird to use water table topography, find a better word. Please also revise them accordingly in the later part of the manuscript.**

Reviewer 1 suggested the use of ‘water table undulation’, and a short explanation was inserted in the Introduction for clarification. However, the usual scientific term to describe this phenomenon is ‘topography-driven groundwater flow’ (e.g. Mádl-Szőnyi et al., 2023), which has been modified to emphasize that it is not the topography of the surface but the topography of the water table that causes forced convection. In addition, in the expression of ‘topothermohaline convection’, the first term thus directly refers to the effect of the water table topography. For these reasons, we would like to keep the original expression ‘water table topography’.

**Line 13 Replace “combined” with “coupled”.**

Replaced, thank you for clarification.

**Line 37 What is Robinson and Love (2013) improved?**

Robinson and Love (2013) accomplished an analytical stagnation point analysis and investigated the flow pattern asymmetry in a hierarchically nested groundwater system based on the Tóthian unit basin (Tóth 1963). We have inserted a short explanation into the text and added the missing reference.

**Line 70 What is “increase heat transport” mean?**

We have modified the expression in the revised manuscript: ‘intensifies heat transport’.

**Line 132 Replace “balance” with “equilibrium”.**

Done in the revised manuscript.

**Line 157 & Table1 Why are the longitudinal and transverse dispersivity set to 0 m in the synthetic models, and what is the potential influence of setting dispersivity to 0 m.**

In the synthetic models, we aimed to focus attention on the phenomenon of topothermohaline convection, so we compiled the simplest possible model framework, choosing to eliminate the effect of mechanical dispersion. At the same time, we have already taken into account the heterogeneity in nature in the real BTK system ($\alpha_L$=100 m, $\alpha_T$=10 m). In response to the question raised, we incorporated longitudinal and transverse dispersivity ($\alpha_L$=100 m, $\alpha_T$=10 m) into the synthetic base model (Table 2), and the model results are presented and interpreted in the Supplementary material attached to the manuscript, and the effect of dispersion is briefly summarized in the Discussion section.

In short, mechanical dispersion has strengthened the thermohaline dome that forms beneath the discharge zone, increasing its relative size from $A_{sal}$=35% to 50%. This resulted in an increase in the average salt concentration, temperature and water age of the basin, while the average Darcy flux decreased. The change is due to two factors: (1) transverse dispersivity increases the salt flux entering the bottom of the basin, and (2) longitudinal dispersivity effectively mixes the waters in the basin. By the way, the effect of mechanical dispersivity on topohaline (topography-driven forced & haline buoyancy-driven free) convection was analysed in detail by Galsa et al. (2022).

**Line 164 Replace "supposed"**
Replaced to 'proposed'

**Line 170 The quantitative relationship between groundwater density, salinity, and temperature should be incorporated.**
The quantitative relation of the water density and the molecular diffusion depending on the temperature, pressure and salt concentration is presented in the new Supplementary material.

**Line 210 Please include references to support the selected values used in the sensitivity analysis.**
Yes, references have been inserted into the text to support the parameter ranges selected. Note that the parameter ranges used in the sensitivity analysis are so wide that they cover almost all hydrogeological situations.

**Line 391 Have the hydrogeological parameters of the fault been characterized separately? A brief discussion on the potential effect of fault in upwelling old, warm and saline groundwater in the discharge area should be added.**
In this study, we have not investigated the role of the conduit/barrier faults. The faults shown in Figures 10 and 11 only separate the individual geometric units without any specific physical parameters. However, Szijártó et al. (2021) studied the role of conduit faults in the 'topothermal model' of the BTK system and found that they can influence the temperature distribution and the flow field mainly locally. If conduit faults were present in the environment of a high-temperature reservoir, they could, in theory, cause local anomalies both in temperature and salinity, but such surface manifestations do not exist. Only at the margin of the confined and unconfined karst, along the Danube River, the occurrence of springs with different temperatures, chemical composition and yields can be seen even near each other, as already mentioned in the Discussion of the manuscript. To clarify the potential role of faults, a separate paragraph has been dedicated to this point in the Discussion.

**Figures 6, 8 &12 Some words in the figures are difficult to read, possibly due to the use of the color light green. Consider adjusting the color or increasing the font size.**
If the manuscript is accepted, we will definitely modify this colouring on the graphs, just as we will probably have to change some of the colour scales.

Furthermore, minor stylistic and grammatical errors have been corrected in the revised manuscript, which — at the request of the editor — has not been uploaded at this stage of the review.

## References


Gupta, I., Wilson, A.M., and Rostron, B.J.: Groundwater age, brine migration, and large-scale solute transport in the Alberta Basin, Canada, *Geofluids*, 15, 608–620, https://doi.org/10.1111/gfl.12131, 2015.

Kaiser, B.O., Cacace, M., and Scheck-Wenderoth, M.: Quaternary channels within the Northeast German Basin and their relevance on double diffusive convective transport processes: Constraints from 3-D thermohaline numerical simulations, *Geochemistry, Geophysics, Geosystems*, 14 (8), 3156–3175, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/ggge.20192, 2013.

Kaiser, B.O., Cacace, M., Scheck-Wenderoth, M., and Lewerenz, B.: Characterization of main heat transport processes in the Northeast German Basin: Constraints from 3-D numerical models, *Geochemistry, Geophysics, Geosystems*, 12, paper: Q07011, https://doi.org/10.1029/2011GC003535, 2011.

Magri, F., Inbar, N., Siebert, C., Rosenthal, E., Guttman, J., and Möller, P.: Transient simulations of large-scale hydrogeological processes causing temperature and salinity anomalies in the Tiberias Basin, *Journal of Hydrology*, 520, 342–355, https://doi.org/10.1016/j.jhydrol.2014.11.055, 2015.

Robinson, N.I., and Love, A.J.: Hidden channels of groundwater flow in Tóthian drainage basins, Advances in Water Resources 62, 71–78, http://dx.doi.org/10.1016/j.advwatres.2013.10.004, 2013.

Szijártó, M., Galsa, A., Tóth, Á., and Mádl-Szőnyi, J.: Numerical analysis of the potential for mixed thermal convection in the Buda Thermal Karst, Hungary, Journal of Hydrology: Regional Studies, 34, paper: 100783, https://doi.org/10.1016/j.ejrh.2021.100783, 2021.

Tóth, J.: A theoretical analysis of groundwater flow in small drainage basin, *Journal of Geophysical Research*, 68 (16), 4795–4812, https://doi.org/10.1029/JZ068i016p04795, 1963.

Zech, A., Zehner, B., Kolditz, O., and Attinger, S.: Impact of heterogeneous permeability distribution on the groundwater flow systems of a small sedimentary basin, *Journal of Hydrology*, 532, 90–101, http://dx.doi.org/10.1016/j.jhydrol.2015.11.030, 2016.