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PRELIMINARY STUDIES ON THE ROLE PLAYED BY UPWARD CONDUCTIVE HEAT FLUX AND THROUGHFLOW IN THE THINNING PROCESS OF NORTH CHINA CRATON

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ABSTRACT

In recent years, large-scale heat transfer theory in fluid-saturated porous media has been proposed for investigating potential thermal structures within the continental lithosphere [1]. Based on this theory and the consideration of temperature-dependent thermal conductivity of the lithosphere, we investigate the relationship between the mantle conductive heat flux, the lithospheric throughflow and the lithospheric thickness in this preliminary study.

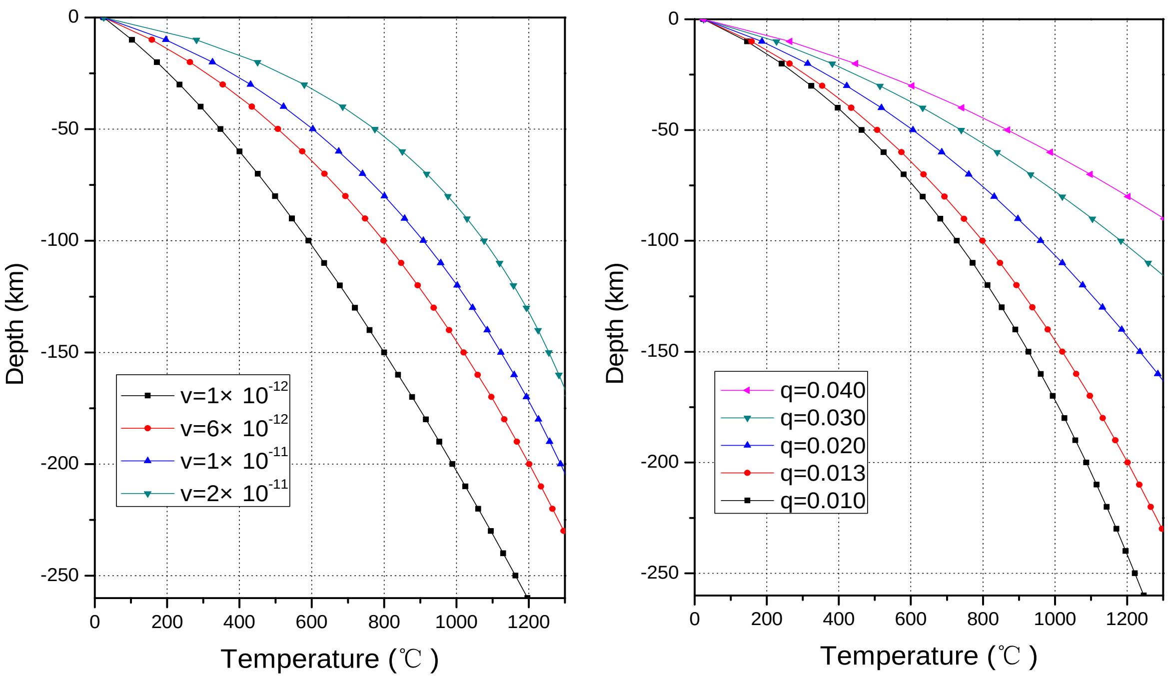

Fig. 1: Effects of upward throughflow and conductive heat flux on thermal structures of the lithosphere. Left: effect of upward throughflow; Right: effect of conductive heat flux

Figure 1 shows some preliminary results, where the effects of both the upward throughflow (see the left part of the figure) and the mantle conductive heat flux (see the right part of the figure) on the temperature distribution within the lithosphere have been investigated. In the case of considering the upward throughflow effect, the mantle conductive heat flux is fixed to a value of $q_b = 13 mW/m^2$ and four different values of upward throughflow are used at the base of the lithosphere. In the case of considering the mantle conductive heat flux effect, the upward througflow is fixed to a value of $v = 6 \times 10^{-12} m/s$ and five different values of mantle conductive heat flux are used. From these preliminary results, it is noted that both the upward throughflow and the mantle conductive heat flux can have significant effects on the lithospheric thickness through the different distribution patterns of temperature within the lithosphere. Generally, the stronger the upward throughflow, the smaller the lithospheric thickness is. The larger the mantle conductive heat flux, the smaller the lithospheric thickness is. The effect of the upward throughflow on the lithospheric thickness in the case of small mantle conductive heat flux is greater than that in the case of large mantle conductive heat flux. Similarly, the effect of mantle conductive flux on the lithospheric thickness in the case of weak upward throuthflow is greater than that in the case of strong upward throughflow.

These preliminary results may be used to understand the thermal thinning processes of the North China Craton (NCC). Since the stable thickness of a cool lithosphere is about $200km$ [2], the upward throughflow velocity of $v = 6 \times 10^{-12} m/s$ can be used as a reference velocity for investigating the thermal thinning of the NCC. For the numerical simulation of the NCC thermal thinning process, the non-uniform distribution of mantle heat flux at the base can be considered to vary from $30 mW/m^2$ in the centre to $15 mW/m^2$ at the both left and right ends of the base[3]. The related numerical results indicate that when thermal equilibrium is reached, the centre of the model base having a temperature of $1200^o C$ can be raised from $200km$ depth into $122km$ depth, implying that the maximum thermal thinning of the NCC is $78km$. If the mantle heat flux at the centre of the base is increased to $40 mW/m^2$, the maximum thermal thinning of the NCC is about $120km$. In this case, the temperature can reach $1500^o C$ at the depth of $140km$, which requires the existence of abnormal mantle heat sources under the lithosphere. This indicates that an increase in the mantle heat flux can significantly reduce the thickness of the lithosphere.

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