two effects is often characterized by the magnetic Reynolds number, which must exceed a threshold value for a magnetic field to be sustained[3]. High fluid velocity and/or low electrical resistance promote a large Reynolds number. It follows that a low resistance should enhance field generation, but only if the velocity is maintained at the necessary level.

Metals are good thermal conductors because electrons are more effective than atomic vibrations in transporting heat. Pozzo and colleagues' simulations confirm that the thermal conductivity of liquid iron under the conditions in Earth's core is several times higher than previous estimates[2]. They predict a value of roughly 125 watts per metre per kelvin ($W\,m^{-1}\,K^{-1}$) at the top of the core and more than 200 $W\,m^{-1}\,K^{-1}$ at the boundary between the outer and inner parts of the core. Such large thermal conductivities allow a substantial amount of heat to be carried by conduction, leaving less heat to drive convection. Convection may even cease in parts of the core[4].

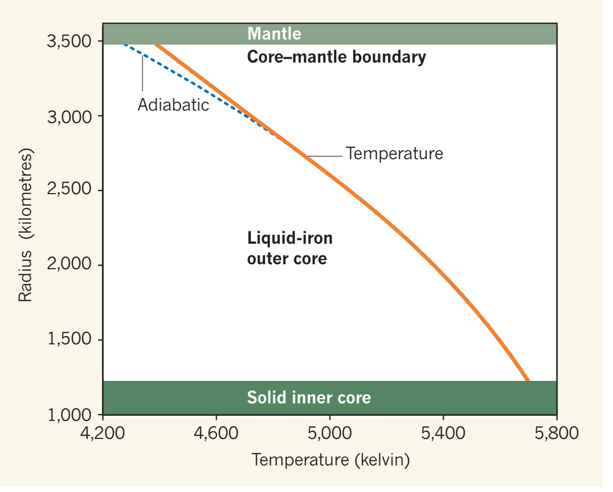

Figure 1 | Temperature profile of Earth's interior. The liquid-iron outer core lies between the mantle and the solid inner core. The increase in temperature across the liquid outer core is well described by an adiabatic process, in which no heat transfer occurs between ascending and descending liquid-iron parcels. Thermal conduction carries heat towards the top of the core. Pozzo and colleagues' study[1] indicates that heat conduction inside the core may exceed the flow of heat across the core–mantle boundary. As a result, the temperature in the boundary region departs from the adiabatic profile to match the boundary's heat flow.

To illustrate the situation, let us consider a representative temperature profile in the liquid core (Fig. 1). Increase of temperature with depth (or pressure) causes conduction of heat towards the top of the core. The depth dependence of temperature in a convecting fluid is well approximated by an adiabatic profile, which is based on the idea that rising and sinking parcels of fluid do not exchange heat. When Pozzo *et al.* applied their new estimate for the thermal conductivity to an adiabatic profile in the core, they obtained a conductive heat flow of 15 terawatts (10^{12} W) near the top of the core. This value may exceed the heat flow across the core–mantle boundary[5]. In that case, warm fluid would accumulate at the top of the core, creating a stably stratified layer. As a result, convection and magnetic-field generation would be largely confined to the region below the stratified layer.

Pozzo *et al.* assess the consequences of high thermal conductivity for magnetic-field generation by constructing thermal 'histories' for the core. They present a suite of histories that could sustain a magnetic field, but in each case a very thick stratified layer or an additional energy source due to decay of radioactive elements would be required in the core. Reasonable arguments can be made against both of these options[6,7], but one or the other seems to be unavoidable for maintaining the magnetic field. If Pozzo and colleagues' calculations are correct, then some of our basic assumptions about the core must be wrong.

One might question the calculations that predict high thermal conductivities. However, similar results have been obtained in independent calculations[8], and there is further experimental support[9] (albeit at temperatures much lower than core conditions). Accepting high thermal conductivity means that heat loss through conduction would substantially weaken thermal convection. A modest (subadiabatic) heat flow from the core would confine convection to a small region below a thick, thermally stratified layer. Such a layer would suppress variations in the magnetic field with time, which is at odds with observations. Alternatively, the need for a stratified layer could be eliminated if the heat flow from the core exceeded the heat conducted along the adiabatic profile. However, it is unclear how this high heat flow could be maintained over geological time. Indeed, most studies suggest that the heat flow from the core was higher in the past[10]. Perhaps the answer involves an unknown energy source. For example, chemical interactions between the core and the mantle might draw on the planet's gravitational energy. However, lack of the necessary understanding of the relevant chemistry at high pressures and temperatures means that this possibility cannot be assessed.

A high thermal conductivity for the liquid-iron core also has implications for the dynamics of the solid inner core. Iron at inner-core conditions is under higher pressure, and probably has a lower concentration of impurities, than iron in the overlying liquid core. Both of these factors would increase the thermal conductivity, so the value in the inner core should exceed 200 $W\,m^{-1}\,K^{-1}$. Such a high value would make convection in the inner core[11], including its 'translational' form[12,13], unlikely. Instead, the inner core should cool by conduction. In such conditions, strong thermal stratification would develop and radial motion would effectively be suppressed. Because radial motion in the inner core is often invoked to explain the directional dependence (anisotropy) of seismic-wave speed in the inner core[14], the high values of thermal conductivity should force researchers to look elsewhere for the cause of the seismic anisotropy.

It is remarkable that a modest change in thermal conductivity can have such a dramatic affect on the dynamics of Earth's core. More broadly, the latest study reveals how the properties of liquid iron make the operation of magnetic dynamos in terrestrial planets even more precarious than was previously believed. We are left with the challenge of understanding how Earth has succeeded in maintaining its magnetic field over most of geological time. ■

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CORRECTION

In the News & Views article 'Cancer biology: The director's cut' by Antonio Gentilella and George Thomas (*Nature* **485**, 50–51; 2012), the messenger RNA transcript encoding YB1 was incorrectly referred to as a 5′ TOP mRNA. The transcript should have been described as containing a pyrimidine-rich translational element (PRTE).