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EXOPLANETS

Mantle convection in super-Earths

Mantle convection — the cycling of heat and material in the silicate interiors of planets — dictates many planetary characteristics, from planetary cooling and magnetism to atmospheric composition and habitability. Characterizing the relationship between mantle convection and planetary mass is a key challenge for understanding rocky exoplanets.

So far, equation-of-state models based on extrapolation from conditions in Earth's mantle have ignored mineral phase transitions at pressures expected in super-Earths. To overcome this limitation, Arie van den Berg and colleagues developed a new material model based on ab initio calculations of mineral properties. They simulated convection in planets up to 20 Earth masses and identified three convective regimes: below 4 Earth masses, vigorous convection occurs throughout the mantle; from 4 to 12 Earth masses, convection is slow and concentrated in a shallow, mobile zone; and above 12 Earth masses, a mid-mantle layer of high viscosity separates two vigorous-convection zones. In the lower zone, perovskite ($MgSiO_3$) breaks down to Mg and Si oxides, leading to a low viscosity layer above the core–mantle boundary, characterized by small-scale convective structures (see the image).

van den Berg et al. suggest that further research into high-pressure phase changes and lower mantle convective regimes could reveal whether super-Earths have core dynamos capable of generating magnetic fields.

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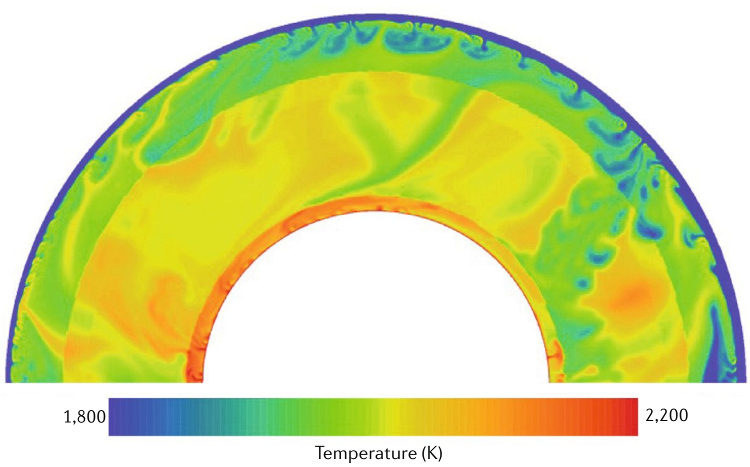
ORIGINAL ARTICLE van den Berg, A. P. et al. Mass-dependent dynamics of terrestrial exoplanets using ab initio mineral properties. *Icarus.* **317**, 412–426 (2019)



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