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On the driving forces of the Pangea breakup and northward drift of the Indian subcontinent

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During the breakup of the supercontinent Pangea, the Indian subcontinent became isolated from the southern part of Pangea, called Gondwanaland, at around 130 Ma, moved northwards, and eventually collided with Eurasia to form the Himalayas at around 40–50 Ma. The reason why the Indian subcontinent moved at such a high speed of up to c. 20 cm/yr remains a controversial issue in geodynamics. Here, numerical simulation of 3-D spherical mantle convection with an Earth-like Rayleigh number is reported, considering the assembly of highly viscous continental blocks with the configuration of Pangea, to determine the geodynamic mechanisms of the Pangea breakup, the subsequent continental drift, and the high-speed northward drift of the Indian subcontinent.

Our numerical simulations approximately reproduced the process of continental drift from the breakup of Pangea at 200 Ma to the present-day continental distribution. These simulations revealed that a major factor in the northward drift of the Indian subcontinent was the large-scale cold mantle downwelling that developed spontaneously in the North Tethys Ocean, attributed to the overall shape of Pangea. The strong lateral mantle flow caused by the high-temperature anomaly beneath Pangea, due to the thermal insulation effect, enhanced the acceleration of the Indian subcontinent during the early stage of the Pangea breakup. The large-scale hot upwelling plumes from the lower mantle, initially located under Africa, might have contributed to the formation of the large-scale cold mantle downwelling in the North Tethys Ocean.

References:
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