

We show that three-dimensional spherical shell mantle convection with realistic mantle viscosity structure, convective vigor and internal heating rate is characterized by either spherical harmonic degree-1 planform with a major upwelling in one hemisphere and a major downwelling in the other hemisphere when continents are absent, or degree-2 planform with two antipolar major upwellings when a supercontinent is present. We propose that due to modulation of continents, these two modes of mantle convection alternate within the Earth's mantle, causing the cyclic processes of assembly and breakup of supercontinents including Rodinia and Pangea in the last 1 Ga. Our model explains Africa and Pacific antipolar superplumes for the present-day mantle. Our model also explains the basic features of the true polar wander (TPW) for Rodinia and Pangea including their equatorial locations and large variability of TPW inferred from paleomagnetic studies. Our model also suggests that TPW is expected to be more variable and large during supercontinent assembly, but small after a supercontinent acquires its equatorial locations and during supercontinent dispersal.