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The Long-Wavelength Mantle Structure, and the supercontinent Evolution since the Paleozoic

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The Earth's lower mantle structure, as revealed by seismic tomography studies, is best characterized by two large low seismic velocity provinces (i.e., LLSVP) beneath Africa and Pacific and their surrounding, circum-Pacific seismically fast anomalies (i.e., a globally spherical harmonic degree 2 structure). Two competing ideas have been proposed to understand the current degree 2 structure. First, the African and Pacific superplumes have remained largely unchanged for at least the last 300 Myr and possibly much longer. Second, the African superplume is dynamically coupled with surface supercontinent Pangea break-up, and therefore formed sometime after the formation of Pangea (i.e., at 330 Ma). Before and during the assembly of Pangea, the mantle in the African hemisphere is predominated by cold downwelling structures, while the Pacific superplume has been stable for the Pangea supercontinent cycle. This cold downwelling in the African hemisphere during the Pangea assembly could be predicted from a classic plate reconstruction. The surface dynamic topography history and evolution of geomagnetic pole reversal frequency, derived from the African cold downwelling during the Pangea time, are consistent with the observables. Now, the continuation of these two competing ideas goes to more accurately reconstructing the plate motion, and hence the mantle structure during the Pangea assembly. Our talk presents a comprehensive review of recent studies on the degree-2 mantle structure, some advances of plate reconstructions, and mantle dynamic models. Our talk also provides a critical assessment on the validity of the hypothesis of spatially stationary Africa LLSVPs since the early Paleozoic. We also will provide the basic discussion for the supercontinent break-up.

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